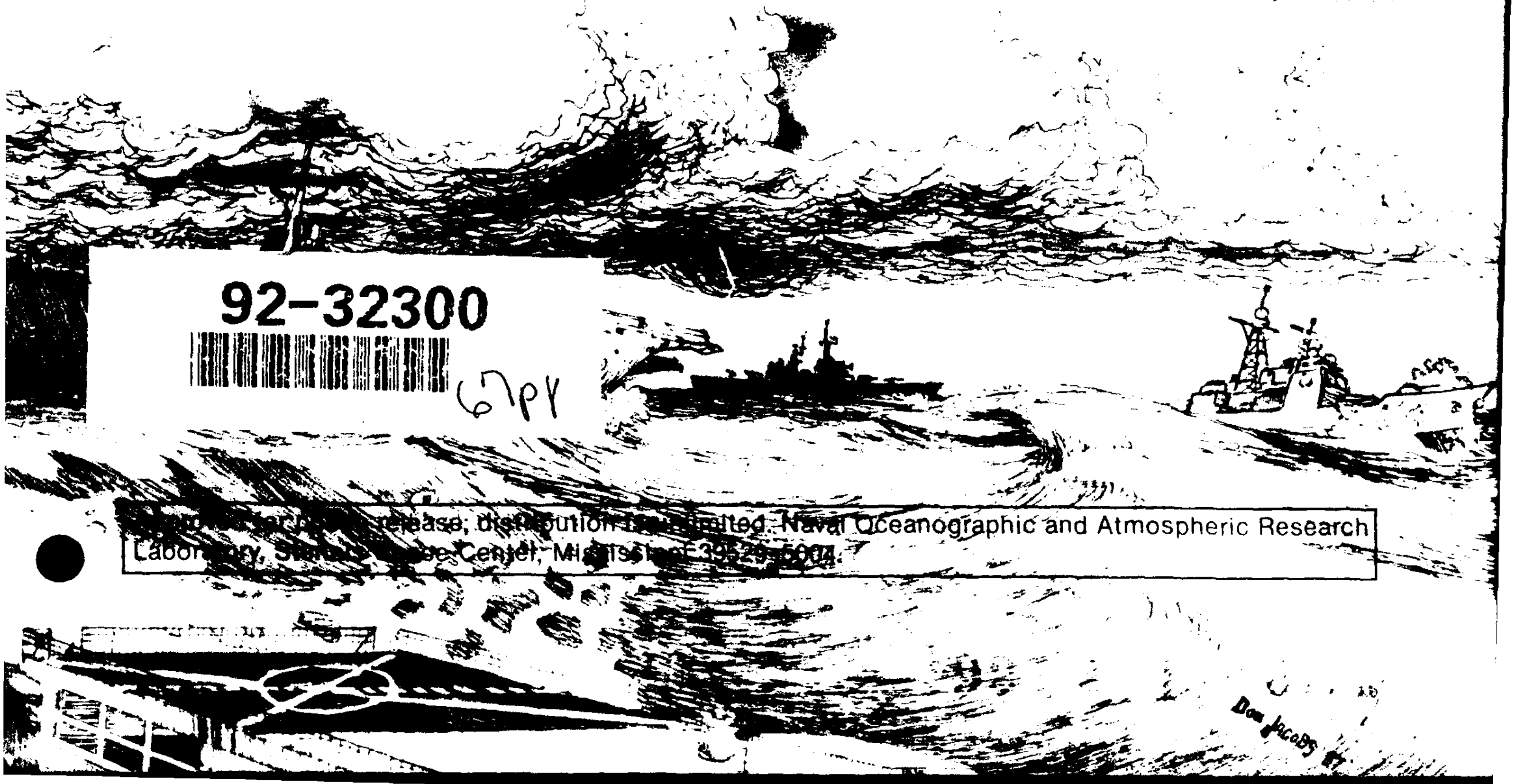
AD-A258 610

Naval Oceanographic and
Atmospheric Research Laboratory

Technical Note 237
September 1992

SEVERE WEATHER GUIDE MEDITERRANEAN PORTS

45. PIRAEUS



ABSTRACT

This handbook for the port of Piraeus, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

ACKNOWLEDGMENTS

The support of the sponsor, Naval Oceanography Command, Stennis Space Center, MS, LCDR E. Steiner, USN, Program Element O&M,N-1, is gratefully acknowledged.

CONTENTS

FOREWORD

This handbook on Mediterranean Ports was developed as part of an ongoing effort at the Meteorology Division, Naval Research Laboratory (NRL), Monterey, to create products for direct application to Fleet Operations. The research was conducted in response to Commander Naval Oceanography Command (COMNAVOCEANCOM) requirements validated by the Chief of Naval Operations (OP-096).

As mentioned in the preface, the Mediterranean region is unique in that several areas exist where local winds can cause dangerous operating conditions. This handbook will provide the ship's captain with assistance in making decisions regarding the disposition of his ship when heavy winds and seas are encountered or forecast at various port locations.

Readers are urged to submit comments, suggestions for changes, deletions and/or additions to Naval Oceanography Command Center (NAVOCEANCOMCEN), Rota with a copy to the oceanographer, COMSIXTHFLT. They will then be passed on to NRL Monterey for review and incorporation as appropriate. This document will be a dynamic one, changing and improving as more and better information is obtained.

PORT INDEX

The following is a list of Mediterranean Ports that have been evaluated since 1988, with future ports and probable year of distribution also included. Computerized versions of these port guides are currently available for those ports with an asterisk (*). Those without the asterisk will be computerized in the near future. Contact the Naval Research Laboratory (NRL), Monterey or NOCC Rota for IBM compatible floppy disk copies.

NO.	PORT
*1	GAETA, ITALY
*2	NAPLES, ITALY
*3	CATANIA, ITALY
*4	AUGUSTA BAY, ITALY
*5	CAGLIARI, ITALY
*6	LA MADDALENA, ITALY
7	MARSEILLE, FRANCE
8	TOULON, FRANCE
9	VILLEFRANCHE, FRANCE
10	MALAGA, SPAIN
11	NICE, FRANCE
12	CANNES, FRANCE
13	MONACO
14	ASHDOD, ISRAEL
15	HAIFA, ISRAEL
16	BARCELONA, SPAIN
17	PALMA, SPAIN
18	IBIZA, SPAIN
19	POLLENSA BAY, SPAIN
20	LIVORNO, ITALY
21	LA SPEZIA, ITALY
22	VENICE, ITALY
23	TRIESTE, ITALY
*24	CARTAGENA, SPAIN
*25	VALENCIA, SPAIN
*26	SAN REMO, ITALY
*27	GENOA, ITALY
*28	PORTO TORRES, ITALY
*29	PALERMO, ITALY
*30	MESSINA, ITALY
*31	TAORMINA, ITALY

NO.	PORT
*32	TARANTO, ITALY
*33	TANGIER, MOROCCO
*34	BENIDORM, SPAIN
*35	ROTA, SPAIN
*36	LIMASSOL, CYPRUS
*37	LARNACA, CYPRUS
*38	ALEXANDRIA, EGYPT
*39	PORT SAID, EGYPT
*40	BIZERTE, TUNISIA
*41	TUNIS, TUNISIA
*42	SOUSSE, TUNISIA
*43	SFAX, TUNISIA
*44	SOUDA BAY, CRETE
*45	PIRAEUS, GREECE
*46	KALAMATA, GREECE
*47	KERKIRA (CORFU), GREECE
*48	KITHIRA, GREECE
*49	THESSALONIKI, GREECE

1993	PORT
	VALLETTA, MALTA
	ISKENDERUN, TURKEY
	IZMIR, TURKEY
	ISTANBUL, TURKEY
	ANTALYA, TURKEY

PREFACE

Environmental phenomena such as strong winds, high waves, restrictions to visibility and thunderstorms can be hazardous to critical Fleet operations. The cause and effect of several of these phenomena are unique to the Mediterranean region and some prior knowledge of their characteristics would be helpful to ship's captains. The intent of this publication is to provide guidance to the captains for assistance in decision making.

The Mediterranean Sea region is an area where complicated topographical features influence weather patterns. Katabatic winds will flow through restricted mountain gaps or valleys and, as a result of the venturi effect, strengthen to storm intensity in a short period of time. As these winds exit and flow over port regions and coastal areas, anchored ships with large 'sail areas' may be blown aground. Also, hazardous sea state conditions are created, posing a danger for small boats ferrying personnel to and from port. At the same time, adjacent areas may be relatively calm. A glance at current weather charts may not always reveal the causes for these local effects which vary drastically from point to point.

Because of the irregular coast line and numerous islands in the Mediterranean, swell can be refracted around such barriers and come from directions which vary greatly with the wind. Anchored ships may experience winds and seas from one direction and swell from a different direction. These conditions can be extremely hazardous for tendered vessels. Moderate to heavy swell may also propagate outward in advance of a storm resulting in uncomfortable and sometimes dangerous conditions, especially during tending, refueling and boating operations.

This handbook addresses the various weather conditions, their local cause and effect and suggests some evasive action to be taken if necessary. Most of the major ports in the Mediterranean will be covered in this series of handbooks. A priority list, established by the Sixth Fleet, exists for the port studies conducted and this list will be followed as closely as possible in terms of scheduling publications.

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	PAGE NUMBER	ENTERED BY

1. GENERAL GUIDANCE

1.1 DESIGN

This handbook is designed to provide ship captains with a ready reference on hazardous weather and wave conditions in selected Mediterranean harbors. Section 2, the captain's summary, is an abbreviated version of section 3, the general information section intended for staff planners and meteorologists. Once section 3 has been read, it is not necessary to read section 2.

1.1.1 Objectives

The basic objective is to provide ship captains with a concise reference of hazards to ship activities that are caused by environmental conditions in various Mediterranean harbors, and to offer suggestions for precautionary and/or evasive actions. A secondary objective is to provide adequate background information on such hazards so that operational forecasters, or other interested parties, can quickly gain the local knowledge that is necessary to ensure high quality forecasts.

1.1.2 Approach

Information on harbor conditions and hazards was accumulated in the following manner:

A. A literature search for reference material was performed.
B. Cruise reports were reviewed.
C. Navy personnel with current or previous area experience were interviewed.
D. A preliminary report was developed which included questions on variou local conditions in specific harbors.
E. Port/harbor visits were made by NOARL personnel; considerable information was obtained through interviews with local pilots, tug masters, etc; and local reference material was obtained.
F. The cumulative information was reviewed, combined, and condensed for harbor studies.

1.1.3 Organization

The handbook contains two sections for each harbor. The first section summarizes harbor conditions and is intended for use as a quick reference by ship captains, navigators, inport/at sea OOD's, and other interested personnel. This section contains:

A. a brief narrative summary of environmental hazards,

B. a table display of vessel location/situation, potential environmental hazard, effect-precautionary/evasion actions, and advance indicators of potential environmental hazards,

C. local wind wave conditions, and

D. tables depicting the wave conditions resulting from propagation of deep water swell into the harbor.

The swell propagation information includes percent occurrence, average duration, and the period of maximum wave energy within height ranges of greater than 3.3 feet and greater than 6.6 feet. The details on the generation of sea and swell information are provided in Appendix A.

The second section contains additional details and background information on seasonal hazardous conditions. This section is directed to personnel who have a need for additional insights on environmental hazards and related weather events.

1.2 CONTENTS OF SPECIFIC HARBOR STUDIES

This handbook specifically addresses potential wind and wave related hazards to ships operating in various Mediterranean ports utilized by the U.S. Navy. It does not contain general purpose climatology and/or comprehensive forecast rules for weather conditions of a more benign nature.

The contents are intended for use in both pre-visit planning and in situ problem solving by either mariners or environmentalists. Potential hazards related to both weather and waves are addressed. The oceanographic information includes some rather unique information relating to deep water swell propagating into harbor shallow water areas.

Emphasis is placed on the hazards related to wind, wind waves, and the propagation of deep water swell into the harbor areas. Various vessel locations/situations are considered, including moored, nesting, anchored, arriving/departing, and small boat operations. The potential problems and suggested precautionary/evasive actions for various combinations of environmental threats and vessel location/situation are provided. Local indicators of environmental hazards and possible evasion techniques are summarized for various scenarios.

CAUTIONARY NOTE: In September 1985 Hurricane Gloria raked the Norfolk, VA area while several US Navy ships were anchored on the muddy bottom of Chesapeake Bay. One important fact was revealed during this incident: Most all ships frigate size and larger dragged anchor, some more than others, in winds of over 50 knots. As winds and waves increased, ships 'fell into' the wave troughs, BROADSIDE TO THE WIND and became difficult or impossible to control.

This wa- a rare instance in which several ships of recent design were exposed to the same storm and much effort was put into the documentation of lessons learned. Chief among these was the suggestion to evade at sea rather than remain anchored at port whenever winds of such intensity are forecast.

2. CAPTAIN'S SUMMARY

The Port of Piraeus is located in the southwestern Aegean Sea on the southernmost peninsula of mainland Greece near 37°56'N, 023°39'E (FICEURLANT, 1987) (Figure 2-1). The island of Crete lies about 150 n mi to the south. The Port is the main port of Athens, the capital of Greece.

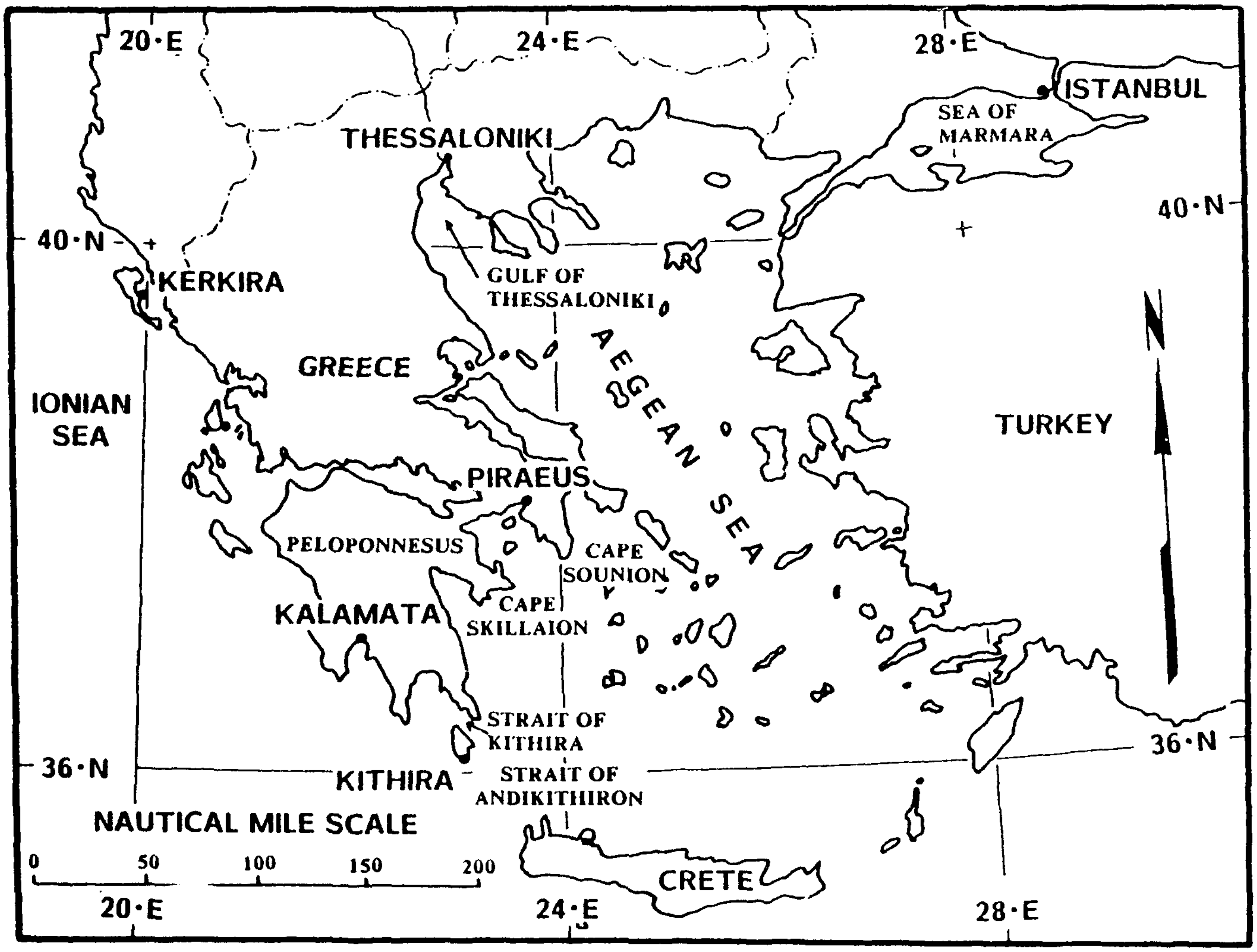


Figure 2-1. Ports of Greece and Surrounding Waters.

The Port lies at the innermost point of the Saronikas Gulf which opens to the south (Figure 2-2). Entry to the Gulf is made between Cape Skillaion and Cape Sounion, about 27 n mi to the east-northeast. Piraeus is situated at the head of the Gulf on the eastern coastline, approximately 25 n mi from the mid-point of the entrance. The western coastline of the Gulf is irregular with many islands and bays, while the eastern side is more uniform and continuous. Both sides feature mountainous terrain with elevations ranging from 2500 ft to near 3500 ft. Numerous rocks, shoals and small islands are found in coastal waters throughout the Gulf.

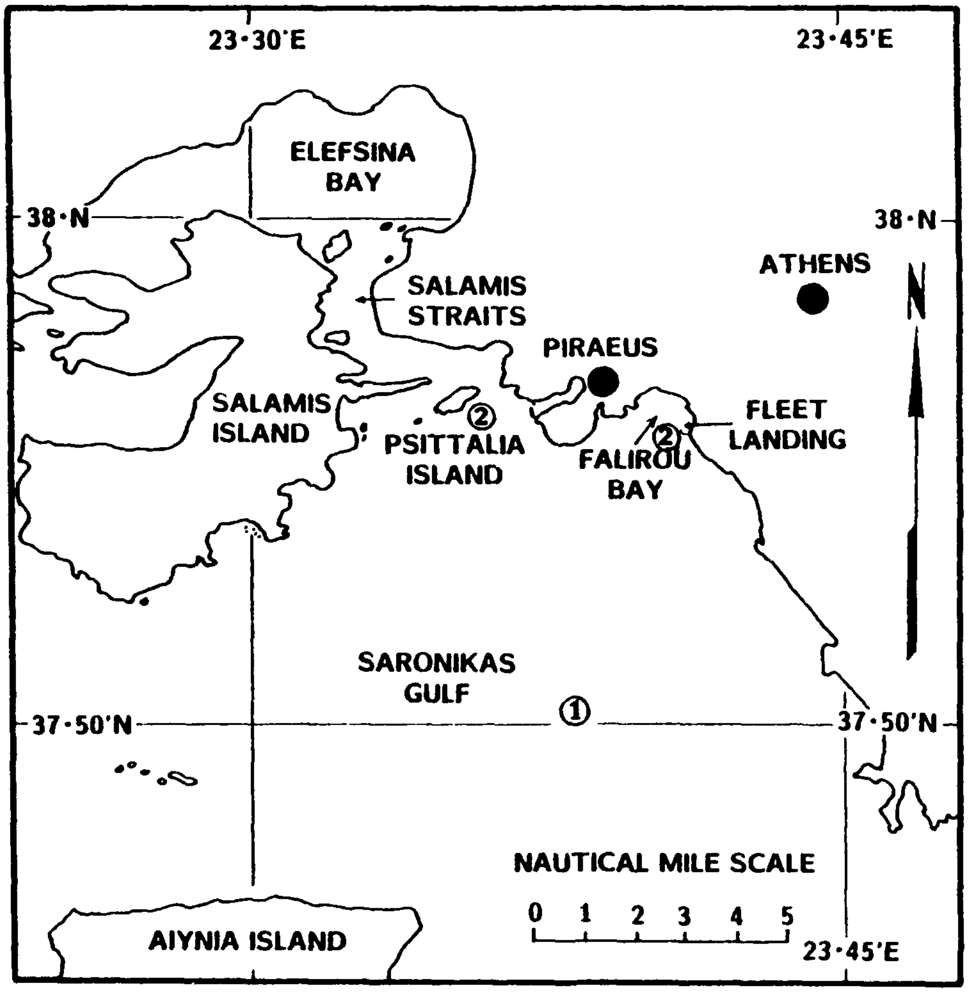


Figure 2-2. Approaches to the Port of Piraeus, Greece.

The harbor facilities for the Port of Piraeus are located within Kendrikos Harbor. The Harbor is situated within a natural bay that extends inland about 1¼ n mi (Figure 2-3). Entry is made from the west through a 170 yd (155 m) wide channel between Themistokleous and B. Yeoryiou Breakwaters (FICEURLANT, 1987). All mooring and wharfage in Kendrikos basin are of concrete construction. Berthing utilized by the U.S. Navy is located on the south side of the Harbor about half-way into the basin (Port Visit, 1990). The Harbor can handle vessels with drafts of up to 31 ft (9.5 m) (FICEURLANT, 1987). Ship traffic is heavy both inside the Harbor and outside the entrance area day and night. Cross traffic, during both day and night, is a particular problem outside the entrance. Pilots are required within Piraeus Harbor. For vessels entering the Harbor, Pilots board about 1000 yd (914 m) west southwest of the entrance area.

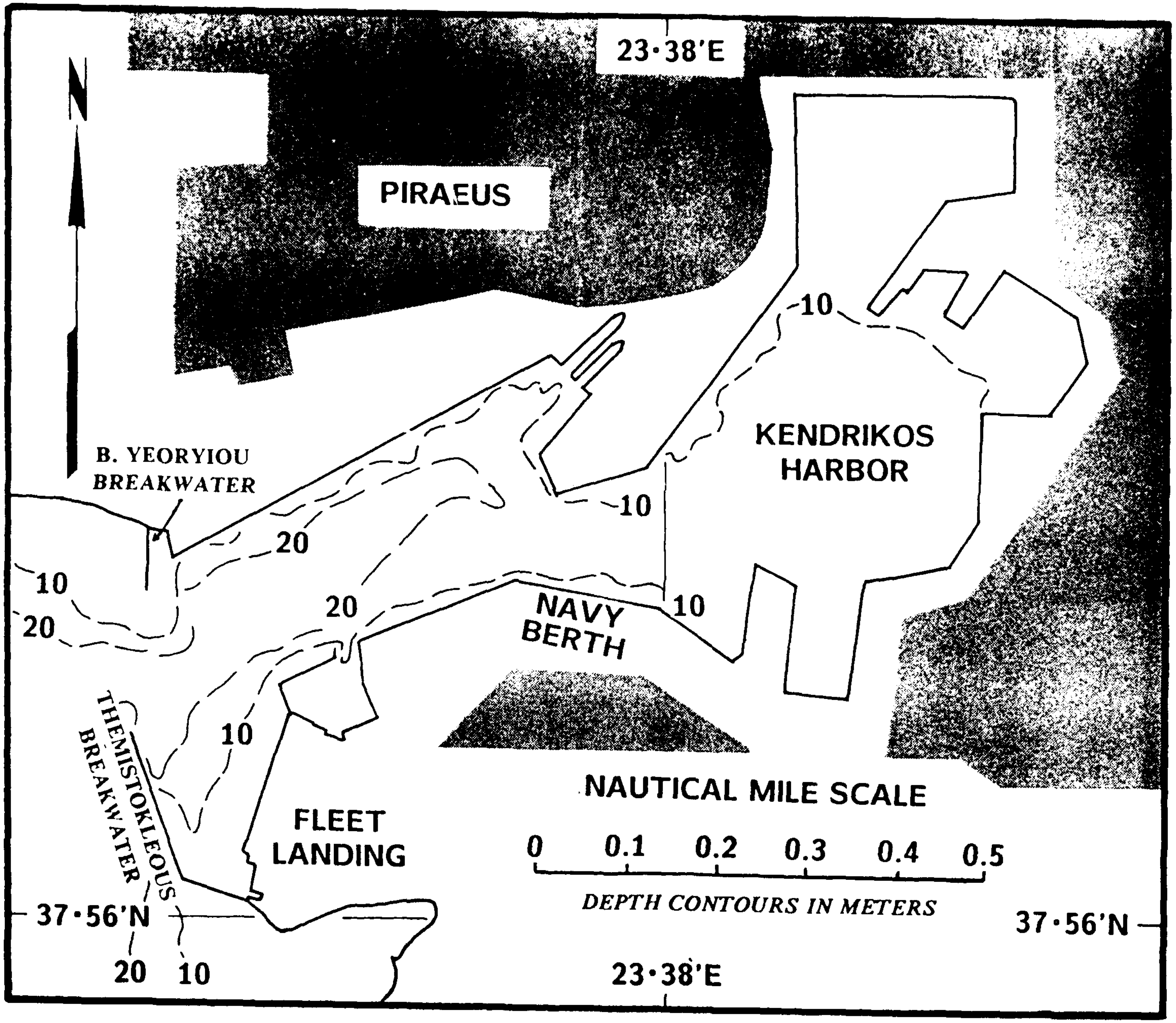


Figure 2-3. The Port of Piraeus, Greece.

There are two anchorage areas in the vicinity of Piraeus that are normally used by U.S. Navy ships. One is located south of the Island of Psittalia, about one n mi west of the harbor entrance. The other is in Falirou Bay approximately 2½ n mi southeast of the Harbor entrance. Carriers and other large ships generally use this second anchorage. Holding is considered good in sand and mud bottoms. Anchor dragging has been reported as a problem in Falirou Bay when anchored shoreward of depths of 22 m or less, due to the hard bottom (Hydrographer of the Navy, 1970). Both anchorage areas are exposed to southerly winds and waves.

There are no significant wave problems inside the Harbor (Port Visit, 1990). Wind conditions cause the most problems at Piraeus (Shaver, Undated). Sudden changes in wind force and direction occur, particularly during the period of March through May, in conjunction with passing migratory cyclones. Coastal squalls are common during strong wind events and can be quite intense. Squalls pose a particular problem for small craft.

Alternative anchorage areas north of Aiynia or Psittalia Islands can be used during strong southerly wind and wave events. Southerly waves tend to build rapidly. Protected anchorages can also be found in Elefsina Bay north of Salamis Island. Note that pilots are required when transiting Salamis Straits. Strong southerly winds associated with eastward tracking cyclones are frequently followed by strong northerly winds. Anchoring to the north of islands in order to escape southerly winds, but in areas exposed to northerly winds, is not recommended.

Visibility is usually good. On rare occasions fog will reduce visibility to 200 yds or less. Conditions are usually worse during the early morning. Restrictions to visibility are associated with high pressure systems. During fall and winter morning visibilities of 2 to 3 n mi in fog and haze are likely, summer haze seldom restricts visibility to less than 5 n mi. However, a haze near the shoreline is prevalent during the twilight hours and may hamper piloting (FICEURLANT, 1987).

Currents and tides are negligible within the Harbor. Some piling up of water within the Harbor, resulting in waves breaking over landing areas used by small craft, occurs during strong southerly wind events.

Specific hazardous environmental conditions, vessel situations, and suggested precautionary/evasive action scenarios for the Port of Piraeus are summarized in Table 2-1.

(1)

Table 2.1 Summary of Hazardous Enviro

HAZARDOUS CONDITIONS	INDICATORS OF POTENTIAL HAZARD
1. S'ly Winds and Waves - * Occur late autumn through winter into spring * Associated with migratory cyclones approaching from the west or Sciroccos from the south out of North Africa * With migratory cyclones: - 28 to 40 kt (force 7-8), waves 15 to 20 ft (4 to 6 m) - cloudy, precipitation, reduced visibility - may be followed by rapid shift to northerly winds * With Sciroccos of late winter into spring: - 22 to 33 kt (force 6-7), waves 5 to 7 ft (1-2 m) - cloudy, widespread light rain, locally heavy squalls	Advance Warning * Migratory cyclones approach from the west, but movement may be erratic * When approaching lows stall over the Ionian Sea, be alert for development of a secondary low to the east and rapid movement through the local area * Numerical forecasts typically handle primary lows well but may be slow in reflecting secondary development * Local Scirocco conditions develop following cyclogenesis over North Africa and slow northward movement of cyclone * Winds shifting to south from prevailing northerly flow, with increasing middle and/or high clouds indicate approaching systems Duration * Migratory cyclone events, 1 to 2 days * Scirocco conditions may persist for several days
2. NW-N'ly Winds - * Occur during winter, result from high pressure over Europe and low pressure over Mediterranean * Winds 34 to 47 kt (force 8-9) * Freezing temperatures. * Squally unsettled weather including snow showers	Advance Warning * High pressure building eastward across Europe with concurrent low center moving eastward over Mediterranean * As cyclone moves to eastward of local area, most intense northerly winds experienced, coldest temperatures likely a day later Duration * Conditions may last for several days if low stalls over eastern Mediterranean or a sequence of lows pass eastward south of local area, while high pressure is maintained over southeastern Europe

azardous Environmental Conditions for the Port of Piraeus, Greece

'S OF IAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT-PRECAUTIONARY/EVASIVE ACTIONS
ones approach but movement ng lows stall n Sea, be lopment of a :o the east nent through	(1) Anchorages	(a) <u>The most hazardous conditions occur with passage of migratory cyclones.</u> * Ships may drag anchor; extended chain and/or two anchors may be required. * Protected anchorages north of islands and in Elefsenia Bay. * Beware of anchorages with northerly exposures due to tendency for rapid shift from southerly to northerly winds. * Allow for shoreward drift.
:asts le primary nay be slow secondary conditions ing /er North v northward :lone to south g northerly ceasing	(2) Small Boats	(a) <u>Small boat runs to/from anchorages will be hazardous and likely curtained.</u> * Ships at anchor may swing. * Swell and local wind waves may be out of phase, makes alongside and/or well deck operations increasingly hazardous. (b) <u>Fleet Landings inside harbor or breakwater of Falirou Bay are protected.</u>
nigh clouds aching one events, 1 :ions may 'eral days	(3) Arriving/ Departing	(a) <u>Following waves and winds may hamper low speed maneuvering</u>. * Expect heavy cross traffic outside harbor entrance. * Cross wind will be experienced during passage through harbor entrance.
uilding ; Europe with center i over s to :al area, ortherly :ed, coldest .kely a day	(1) Anchorages	(a) <u>Strong off-shore winds with squally variable weather conditions.</u> * Rapidly changing conditions may cause ships to swing at anchor. * Extended chain and/or two anchors may be required to prevent anchor dragging toward deeper water. * Freezing temperatures, low wind chills necessitate cold weather operations and gear.
last for f low stalls editerranean of lows pass of local gh pressure over urope	(2) Small Boats	(a) <u>Small boat operations outside harbor generally curtailed for safety reasons.</u> * Rapid onset and variable conditions present particularly hazardous situations for small craft in open water areas. Remain in harbor. * Freezing temperatures and sub-freezing wind chill factor. Use cold weather gear and operating procedures.

(1)

Table 2-1. (cor

HAZARDOUS CONDITIONS	INDICATORS OF POTENTIAL HAZARD
3. N-NE'ly Winds - * Occur most frequently during summer during strong Etesian events * 34 to 40 kt (force 8), no other significant weather	Advance Warning * Strongest Etesian events occur when low pressure trough extends westward from Asia Minor to southwestern coast of Turkey and intensifies * Increasing cloudiness develops over Balkan Peninsula area the day before onset of an Etesian May include scattered thunderstorms during May-June and September-October periods * Winds most intense during July and August Duration * Conditions may last for several days, sometimes for weeks

ble 2-1. (continued)

)F ARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT-PRECAUTIONARY/EVASIVE ACTIONS
	(3) Arriving/ Departing	(a) Beware of rapid fluctuations of wind and weather. * Cross winds prevail over entrance, but may change direction rapidly. * Delay entry/departure during periods of squalls. * Freezing temperatures/low wind chills. Use cold weather gear/operations.
ι events :essure əstward :o st of sifies .ness .kan ie day	(1) Anchorages	(a) Northerly winds prevail throughout the day and night. * Afternoon sea breeze does not develop. * Vessel maneuvering and alongside operations will be additionally hazardous. * Stronger winds and high seas will be experienced over the open Aegean Sea waters.
ın Etesian :ered :ing May- ər-October se during	(2) Small Boats	(a) Small boat runs to/from anchorages likely to be canceled. * Sea breeze effect tends to reduce summer northerly winds during the afternoon. May impact on scheduling. (b) Strong funneling of winds from 020° cause hazardous conditions within harbor.
ıst for netimes for	(3) Arriving/ Departing	(a) Funneling of winds over harbor and entrance area causes handling and berthing problems. * Afternoon sea breeze effect tends to reduce summer time northerly winds. Wind sensitive operations may be best scheduled accordingly. (b) Onset/end of sea breeze will reverse local winds (southerly sea breeze).

SEASONAL SUMMARY OF HAZARDOUS CONDITIONS

WINTER (November through February)

* N'ly winds 34 to 47 kt, high pressure builds over Europe and/or a migratory cyclone passes eastward south of area.
  - wind chill approaches 0°F (-18°C)
  - Duration several days, approach and passage erratic
* S'ly winds (migratory cyclones) 28 to 40 kt, strong northerlies may follow
  - wave/swell to 20 ft in anchorages
  - intense coastal squalls, hazardous to small craft
  - duration 1 to 2 days, onset rapid, rapid wind shifts

SPRING (March through May)

* S'ly winds (Scirocco) 22 to 33 kt
  - waves 5 to 7 ft
  - duration several days, gradual onset
* N'ly winds prevail, less than 15 kt
  - southerly sea breeze 10 to 15 kt about 25% of time

SUMMER (June through September)

* N'ly winds (Etesian) 22 to 27 kt prevail, extremes 34 to 40 kt
  - 40 to 50 kt over exposed Aegean Sea areas
  - strongest events July and August
  - afternoon S'ly sea breeze except during strong Etesian
  - duration 1 to 5 days for strong events

AUTUMN (October)

* Rapid transition to winter weather
  - winter-like cyclone likely after third week

NOTE: For more detailed information on hazardous weather conditions, see previous Table 2-1 in this section and Hazardous Weather Summary in Section 3.

REFERENCES

FICEURLANT, 1987: Port Directory for Piraeus, Greece. Fleet Intelligence Center Europe and Atlantic, Norfolk, VA.

Hydrographer of the Navy, 1970: Mediterranean Pilot. Volume III. Hydrographer of the Navy, London, England.

Shaver, D.W., Undated: Comments on Weather in the Mediterranean. Unpublished manuscript. Naval Oceanographic and Atmospheric Research Laboratory, Atmospheric Directorate, Monterey, CA 93943-5006*.

*Now Naval Research Laboratory, Monterey, CA 93943-5006.

Port Visit Information

May 1990: NOARL Meteorologists R. Fett and R. Miller met with the Senior Pilot, Mr. J. Roussos, to obtain much of the information included in this port evaluation.

3. GENERAL INFORMATION

This section is intended for Fleet meteorologists/ oceanographers and staff planners. Section 3.5 includes a general discussion of hazards and Table 3-5 provides a summary of vessel locations/situations, potential hazards, effect-precautionary/evasive actions, and advance indicators and other information by season.

3.1 Geographic Location

The Port of Piraeus is located in the southwestern Aegean Sea on the southernmost peninsula of mainland Greece near 37°56'N, 023°39'E (FICEURLANT, 1987) (Figure 3-1). The island of Crete lies about 150 n mi to the south. The Port is the main port of Athens, the capital of Greece.

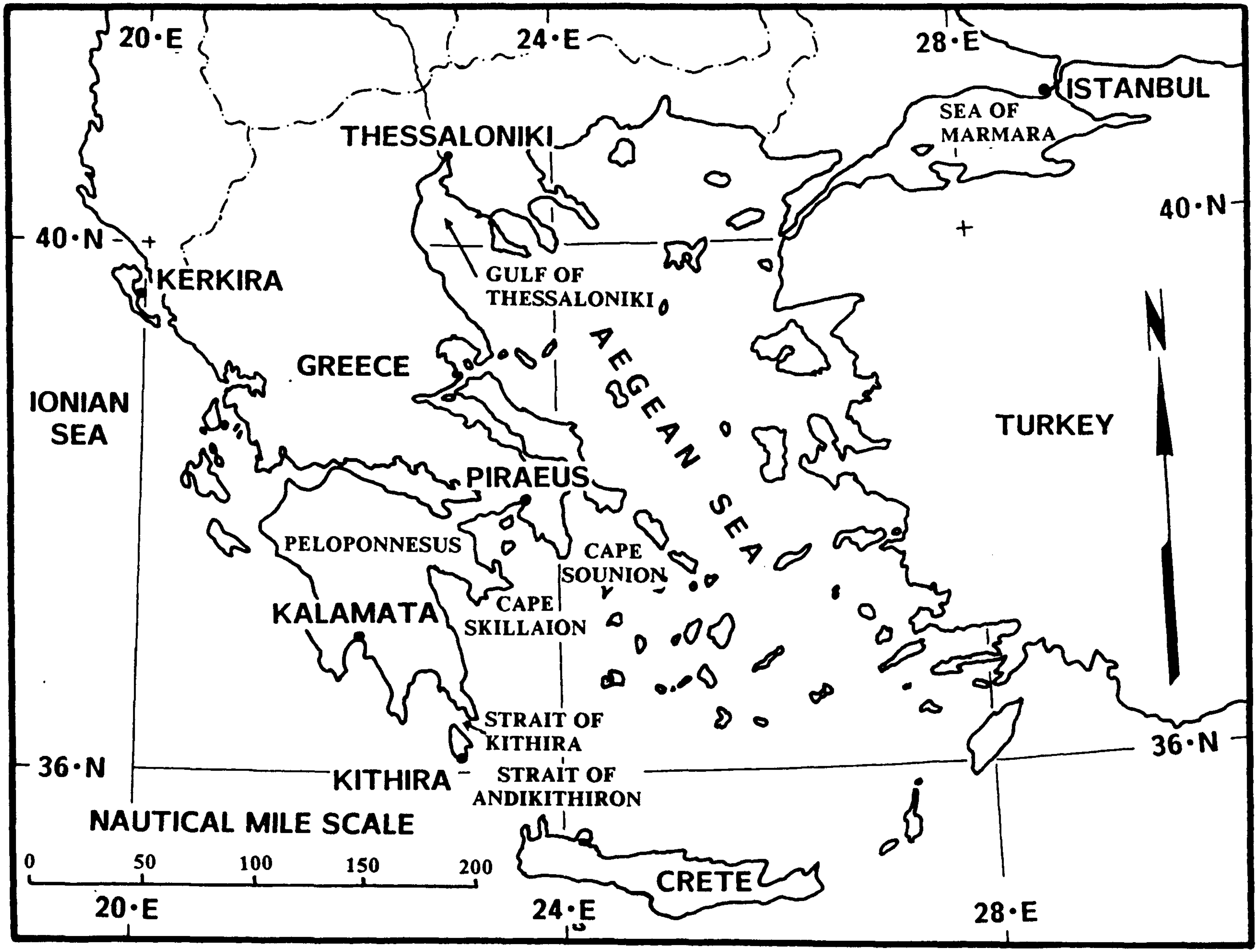


Figure 3-1. Ports of Greece and Surrounding Waters.

The Port lies at the innermost point of the Saronikas Gulf which opens to the south (Figure 3-2). Entry to the Gulf is made between Cape Skillaion and Cape Sounion, about 27 n mi to the east-northeast. Piraeus is situated at the head of the Gulf on the eastern coastline, approximately 25 n mi from the mid-point of the entrance. The western coastline of the Gulf is irregular with many islands and bays, while the eastern side is more uniform and continuous. Both sides feature mountainous terrain with elevations ranging from 2500 ft to near 3500 ft. Numerous rocks, shoals and small islands are found in coastal waters throughout the Gulf.

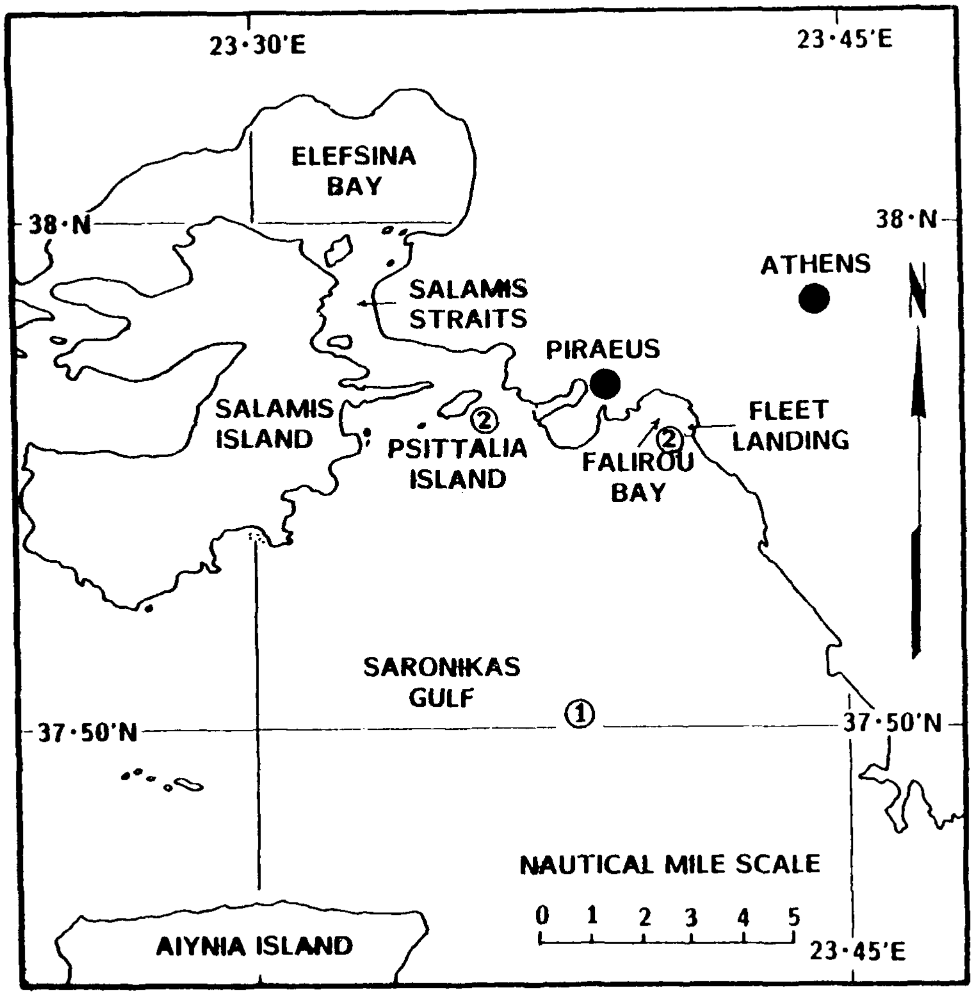


Figure 3-2. Approaches to the Port of Piraeus, Greece.

The harbor facilities for the Port of Piraeus are located within Kendrikos Harbor. The Harbor is situated within a natural bay that extends inland about 1¼ n mi (Figure 3-3). Entry is made from the west through a 170 yd (155 m) wide channel between Themistokleous and B. Yeoryiou Breakwaters (FICEURLANT, 1987). All mooring and wharfage in Kendrikos basin are of concrete construction. Berthing utilized by the U.S. Navy is located on the south side of the Harbor about half-way into the basin (Port Visit, 1990). The Harbor can handle vessels with drafts of up to 31 ft (9.5 m) (FICEURLANT, 1987). Ship traffic is heavy both inside the Harbor and outside the entrance area day and night. Cross traffic, during both day and night, is a particular problem outside the entrance. Pilots are required within Piraeus Harbor. For vessels entering the Harbor, Pilots board about 1000 yd (914 m) west southwest of the entrance area.

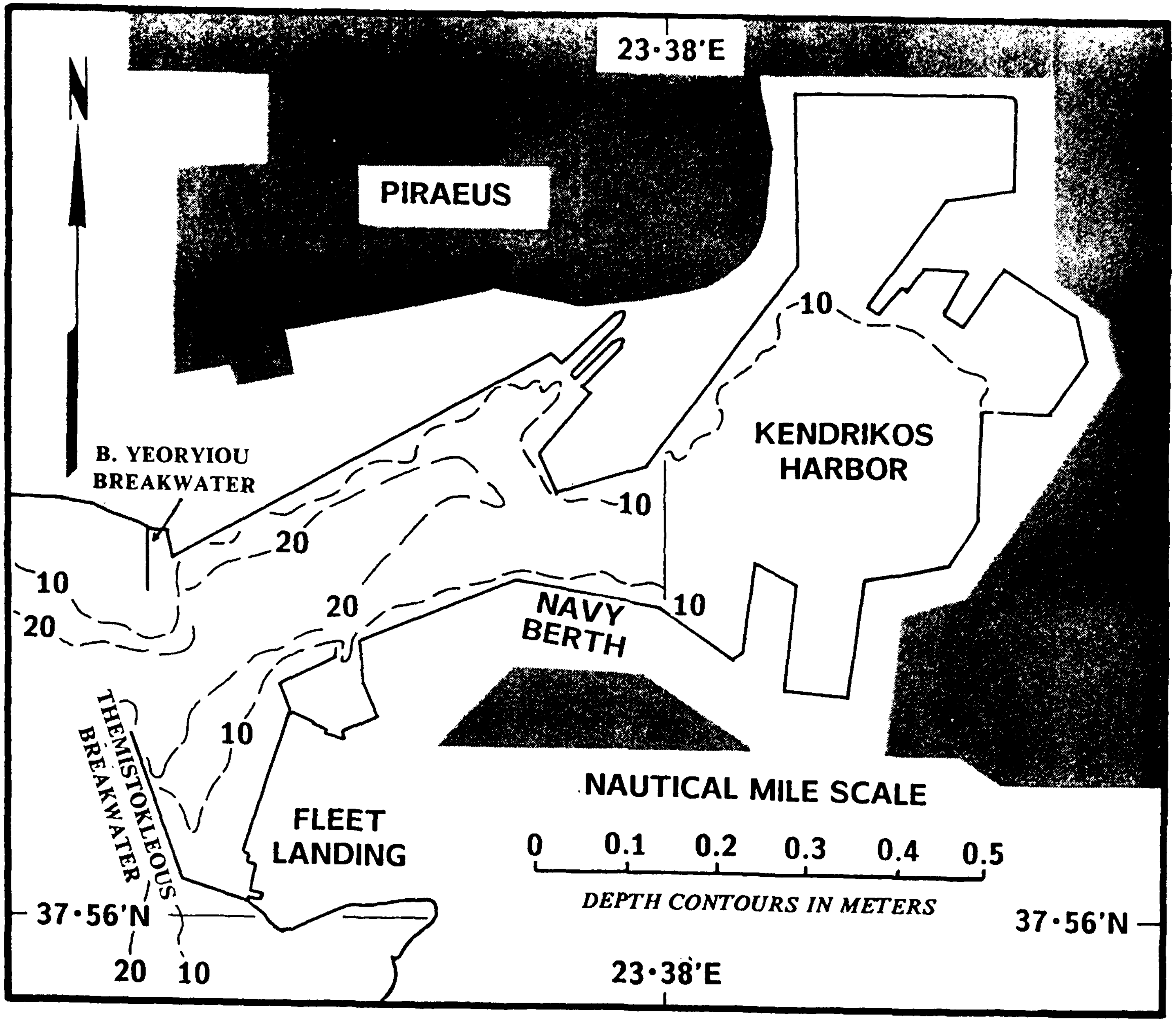


Figure 3-3. The Port of Piraeus, Greece.

There are two anchorage areas in the vicinity of Piraeus that are normally used by U.S. Navy ships. One is located south of the Island of Psittalia, about one n mi west of the harbor entrance. The other is in Falirou Bay approximately 2½ n mi southeast of the Harbor entrance. Carriers and other large ships generally use this second anchorage. Holding is considered good in sand and mud bottoms. Anchor dragging has been reported in Falirou Bay as a problem when anchored shoreward of depths of 22 m or less, due to the hard bottom (Hydrographer of the Navy, 1970). Both anchorage areas are exposed to southerly winds and waves.

3.2 Qualitative Evaluation of the Port of Piraeus

There are no significant wave problems inside the Harbor (Port Visit, 1990). Wind conditions cause the most problems at Piraeus (Shaver, Undated). Sudden changes in wind force and direction occur, particularly during the period of March through May, in conjunction with passing migratory cyclones. The anchorages are exposed to southerly winds and waves. Southerly waves tend to build rapidly.

Alternative anchorage areas in Elefsina Bay or north of Aiynia or Psittalia Islands can be used during strong southerly wind and wave events. Strong southerly winds associated with eastward tracking cyclones are frequently followed by strong northerly winds. Anchoring to the north of islands in order to escape southerly winds, but in areas exposed to northerly winds, is not recommended.

3.3 Currents and Tides

Currents and tides are negligible within Kendrikos Harbor (FICEURLANT, 1987). Under strong southerly winds tides may reach 1 ft, with persistent northerly winds over several days, 2 ft.

3.4 Visibility

Visibility is usually good. On rare occasions fog will reduce visibility to 200 yds or less. Conditions are usually worse during the early morning. Restrictions to visibility are associated with high pressure systems. During fall and winter morning visibilities of 2 to 3 n mi in fog and haze are likely, summer haze seldom restricts visibility to less than 5 n mi. However, a haze near the shoreline is prevalent during the twilight hours and may hamper piloting (FICEURLANT, 1987).

3.5 Hazardous Conditions

The Port of Piraeus is located within a small enclosed bay and, as such, is protected from all significant wave conditions. Winds in this area are generally limited to maximum speeds of 41 to 47 kt in winter and 34 to 40 kt in summer. Northerly winds prevail throughout the year. During summer they are extremely persistent with very few exceptions other than afternoon southerly sea breezes along south-facing coastlines. During winter wind conditions are much more variable, with rapid changes from strong southerly to northerly or vice versa, in response to the passage of cyclonic systems. Due to the mountainous terrain of the region there is a tendency for the sudden onset of strong coastal squalls, particularly during northerly flow. These squalls are especially hazardous for small craft.

A seasonal summary of the various known environmental hazards that may be encountered in the Port of Piraeus area follows.

A. Winter (November through February)

The regional winter circulation pattern is dominated by high pressure over the relatively cold land masses to the north and east with low pressure over the warm Mediterranean Sea. Migratory cyclones approach the area from the western quadrant. Over the Aegean Sea cyclones may take either a northeasterly track towards the Black Sea or continue eastward passing south of the local area. Movement of winter migratory cyclones tends to become quite erratic over this region of the Mediterranean. Approaching cyclones frequently stall over the Ionian Sea, the southern Aegean, or near Cyprus, followed by development of a secondary cyclonic center that moves rapidly eastward. Cyclones tracking eastward between the Port and Crete tend to produce the strongest winds. An additional hazardous condition associated with cyclones that pass south of the Port is the tendency for a rapid shift from strong southerlies (28 to 40 kt) with waves of 15 to 20 ft to even stronger northerlies (34 to 47 kt) as the center moves eastward past the local area. Temperatures will drop significantly with the storm passage and wind reversal. Freezing temperatures with wind chills below 0°F (-18°C) (Table 3-1) are likely within 24 to 48 hours, during December through March, following the eastward passage of a cyclone south of the local area.

Table 3-1. Wind Chill. The cooling power of the wind expressed as "Equivalent Chill Temperature" (adapted from Kotsch, 1983).

Wind	Speed	Cooling Power of Wind expressed as "Equivalent Chill Temperature"								
Knots	MPH	Temperature (°F)								
Calm	Calm	40	35	30	25	20	15	10	5	0
		Equivalent Chill Temperature								
3-6	5	35	30	25	20	15	10	5	0	-5
7-10	10	30	20	15	10	5	0	-10	-15	-20
11-15	15	25	15	10	0	-5	-10	-20	-25	-30
16-19	20	20	10	5	0	-10	-15	-25	-30	-35
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55

During those periods when a high pressure ridge extends over the Balkan Peninsula and Aegean Sea persistent fog may occur primarily during morning hours with visibilities restricted to 3 n mi or less

B. Spring (March through May)

The transition from winter to summer is prolonged with alternating periods of winter- and summer-like conditions. The frequency, intensity and extent of Scirocco conditions are at a maximum during spring. Scirocco conditions tend to develop slowly over a day or two, but may persist for several days. Sciroccos bring cloudy weather with light, widespread precipitation and heavier localized terrain induced rain. Typical winds are south-to-southeasterly 22 to 33 kt and waves 5 to 7 ft. These are the most troublesome directions of open sea waves for wave conditions outside the Harbor (see Section 3.6.2). Open sea conditions can be expected throughout the southerly exposed anchorage areas. A tendency for the piling up of water in the Harbor was reported by Shaver (undated), under persistent strong southerly winds. This condition can cause problems for small boats at boat landings with minimum freeboard.

By late spring the persistent northerly flow of summer begins to dominate. A southerly 10 to 15 kt sea breeze will develop during the afternoons of late spring days when the prevailing northerly flow is less than about 15 kt. The sea breeze becomes established by mid-morning and lasts until about sunset. The sea breeze typically occurs about 25% of the days during late spring.

C. Summer (June through September)

There are no truly hazardous weather conditions to ocean-going vessels during summer in the Piraeus area. The prevailing wind becomes northerly (Etesian) in response to the development of the thermal low over southwestern Asia with relatively high pressure over the Mediterranean. A thermal low pressure trough extends westward along the southern coast of Turkey from the thermal low. The strongest northerly wind events will cause hazardous conditions for small craft in and around the harbor of Piraeus. However, during strong Etesian events the winds over the fully exposed areas of the Aegean Sea may reach storm force resulting in hazardous conditions for all size vessels.

In the vicinity of the Harbor the Etesian typically blows at 11 to 21 kt with fairly frequent periods of 22 to 27 kt. The strongest Etesians, which occur during July and August, may reach 34 to 40 kt. These most intense conditions develop when the thermal trough is most intense and/or shifted to its westerly most position off southwest Turkey.

While no local indicators were identified during the 1990 Port Visit to Piraeus the tendency for an increase in clouds the day before and first day of Etesian events was noted as a well-known fact by Aegean Sea fishermen in Reiter (1971). During July and August the clouds are typically limited to scattered altocumulus on the day preceding the Etesian while thunderstorm activity over Greece tends to occur on the day before and first day of an Etesian during the May-June and September-October periods.

D. Autumn (October)

The most hazardous aspect of weather in autumn, as elsewhere in the Mediterranean, is the rapidity with which the winter-type pattern is established. On average, the winter pattern is established around the end of the third week of October over the northern Mediterranean. While the first storms are not likely to be as intense as those later in the winter, the marked change from the summer Mediterranean weather can catch people unaware and unprepared. A migratory cyclone approaching from the west indicates the onset of winter-like events. Conditions relating to migratory lows are described in the Winter Section.

3.6 Harbor Protection

The Port of Piraeus is located within a natural bay with breakwaters defining its westward-facing entrance. As such it is protected from all significant wave action. Northerly and southerly winds of up to 34 to 47 kt are experienced over the water areas. However, heavy weather is not considered a significant problem inside the Harbor (Port Visit, 1990). The anchorages are fully exposed to southerly winds and waves.

3.6.1 Wind and Weather

The regional terrain around Piraeus is mountainous resulting in marked local influences on wind and weather. Wind is the primary problem within the Harbor. Northerly winds prevail throughout the year. The worst wind conditions in the Harbor occur when the synoptic scale flow is from 020° to 040° and is funneled through the mountain pass to the north-northeast, resulting in enhanced winds spreading out over the Harbor (Shaver, undated). The most hazardous conditions outside the Harbor, in the anchorage areas, occur with south-to-southeast winds. These conditions occur when migratory lows track eastward south of the local area. Southerly winds can also affect conditions in the Harbor due to the piling up of water, plus wave energy passing through the entrance. Under these conditions waves may break over the low docking facilities used for Fleet Landings.

When a migratory low tracks over or to the north of the local area south-southwest to north winds are experienced. Wind from the western semicircle must be quite strong to cause significant problems; however, boating problems may occur in the eastern part of the Harbor when westerlies exceed about 25 kt.

During periods of moderate regional Etesian wind conditions the local wind pattern will be northeast 8 to 15 kt during the morning, shifting to south-to-southwest 10 to 15 kt (seabreeze) during the afternoon, then becoming northeast 5 to 10 kt after sunset.

Coastal squalls can be quite intense and pose a particular threat for small craft. High winds and waves with locally heavy precipitation may develop rapidly with large variations in conditions over the distance of only a few miles.

3.6.2 Waves

The port area is protected by land from northwest clockwise through east. It is, however, exposed to waves from other directions. The outer harbor is adversely affected by southerly waves. The roadstead is exposed to southerly swell and wind waves from all directions. Table 3-2 provides the shallow water wave conditions at the two designated points as shown in Figure 3-2 when deep water swell enters the area. Under strong southerly flow deep water swell up to 15 to 20 ft may enter the Bay and reach the anchorage areas.

Example: Use of Table 3-2.

For a deep water wave condition of 16 feet, 12 seconds, from 180°, the approximate shallow water wave conditions are:

Point 1: 14-15 feet, 12 seconds, from 180°
Point 2: 11-12 feet, 12 seconds, from 205°

Table 3-2. Shallow water wave directions and relative height conditions versus deep water period and direction (see Figure 3-3 for location of the points).

FORMAT: Shallow Water Direction
Wave Height Ratio: (Shallow Water/Deep Water)

PIRAEUS POINT 1: Inner Portion of Separation Zone Depth 240 ft

Period (sec)	6	8	10	12	14	16
Deep Water Direction	Shallow Water Direction and Height Ratio					
120°	130° .4	130° .4	130° .4	130° .3	130° .2	135 .2
150°	150° 1.0	150° 1.0	150° .8	150° .7	155° .7	155° .8
180°	180° 1.0	180° 1.0	180° 1.0	180° .9	180° .7	180° .6
210°	210° .7	210° .3	205° .4	205° .5	200° . 3	200° .3

PIRAEUS POINT 2: Anchorage Areas Depth 95 ft

Period (sec)	6	8	10	12	14	16
Deep Water Direction	Shallow Water Direction and Height Ratio					
150°	170° .6	170° .6	165° .5	175° .5	180° .4	180° .3
180°	180° 1.0	190° .9	190° .7	205° .7	195° .7	205° .6
210°	200° .5	220° .5	225° .5	200° .2	200° .2	210° .2

Situation-specific shallow water wave conditions resulting from deep water wave propagation are given in Table 3-2, while the seasonal climatology of wave conditions resulting from the propagation of deep water waves into the area are given in Table 3-3. If the actual or forecast deep water wave conditions are known, the expected conditions at the two specified area points can be determined from Table 3-2. The mean duration of the condition, based on the shallow water wave heights, can be obtained from Table 3-3.

Example: Use of Tables 3-2 and 3-3.

The forecast for wave conditions tomorrow (winter case) outside the harbor are:
8 feet, 12 seconds, from 180°

Expected shallow water conditions and duration:

	Point 1	Point 2
Height	7 feet	6 feet
Period	12 seconds	12 seconds
Direction	from 180°	from 205°
Duration	14 hours	12 hours

Interpretation of the information from Tables 3-2 and 3-3 provides guidance on the local wave conditions expected tomorrow at the specified area points. The duration values are mean values for the specified height range and season. Knowledge of the current synoptic pattern and forecast/expected duration should be used when available.

Possible applications to small boat operations are selection of the mother ship's anchorage point, and/or areas of small boat work. The duration information provides insight as to how long before a change can be expected. The local wave direction information can be of use in selecting anchorage configuration and related small boat operations, including tending activities.

Table 3-3. Shallow water climatology as determined from deep water wave propagation. Percent occurrence, average duration or persistence, and wave period of maximum energy for wave height ranges of greater than 3.3 ft (1 m) and greater than 6.6 ft (2 m) by climatological season.

PIRAEUS POINT 1:	WINTER	SPRING	SUMMER	AUTUMN
>3.3 ft (1 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	16	7	1	9
Average Duration (hr)	13	12	8	18
Period Max Energy (sec)	9	8	6	9
>6.6 ft (2 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	4	1	<<1	<<1
Average Duration (hr)	14	8	6	6
Period Max Energy (sec)	10	9	11	9
PIRAEUS POINT 2:	WINTER	SPRING	SUMMER	AUTUMN
>3.3 ft (1 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	15	4	<1	9
Average Duration (hr)	12	10	7	11
Period Max Energy (sec)	9	9	10-11	9
>6.6 ft (2 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	2	0	0	0
Average Duration (hr)	10	NA	NA	NA
Period Max Energy (sec)	11	NA	NA	NA

Local wind wave conditions are provided in Table 3-4 for Piraeus Points 1 and 2. The fetch lengths are specifically for the two points. The time to reach the fetch limited height assumes an initial flat ocean. With a pre-existing wave height, the times are shorter.

Table 3-4. Piraeus. Local wind waves for fetch limited conditions (based on JONSWAP model). Due to the irregular distances between points 1 and 2 and the surrounding coastal and island features the distances for fetch limited waves are provided without specific directions. The sample provided should cover most situations for locations from the inner portion of the separation zone (Point 1) to the anchorage areas outside the harbor (Point 2).

FORMAT: Height (feet)/Period (seconds)
Time (hours) to reach fetch limited height

Direction and Fetch Length (n mi)	Local Wind Speed (kt)				
	18	24	30	36	42
5	<2 ft	2/3-4 1	2-3/3-4 1	3/3-4 1-2	3-4/3-4 1
10	2/3-4 1-2	3/3-4 2	3-4/4 2	4/4-5 1-2	5/5 1-2
15	2-3/4 2	3-4/4 2	4/4-5 2	5/5 2	6/5 2
20	3/4-5 2-3	4/4-5 3	5-5 3	6/5-6 3-4	7/5-6 3
25	3-4/4-5 3	4/5 3	5-6/5 3	6-7/6 3	7-8/6 3
30	4/4-5 3	5/5-6 4	6/6 3-4	7/6 3-4	8/6-7 3

Example: Small boat wave forecasts for Point 2 using a 30 n mi fetch (based on the assumption that swell is not a limiting condition).

Forecast for Tomorrow:

Time	Wind (Forecast)	Waves Tables 3-4
prior to 1000 LST	SW 6-8 kt	< 2 ft
1000 to 1400	SW 16-20 kt	4 ft at 4-5 sec by 1300
1400 to 1900	SW 22-26 kt	building to 5 ft at 5-6 sec

Interpretation: Assuming that the limiting factor is waves greater than 3 feet, small boat operations will become restricted shortly after 1000.

Combined wave heights are computed by finding the square root of the sum of the squares of the wind wave and swell heights. For example, if the wind waves were 3 ft and the swell 8 ft the combined height would be about 8.5 ft.

$$\sqrt{3^2 + 8^2} = \sqrt{9 + 64} = \sqrt{73} \approx 8.5$$

Note that the increased height is relatively small. Even if the two wave types were of equal height the combined heights are only 1.4 times the equal height. In cases where one or the other heights are twice that of the other, the combined height will only increase over the larger of the two by 1.12 times (10 ft swell and 5 ft wind wave combined results in 11.2 ft height).

3.6.3 Wave Data Uses and Considerations

Local wind waves build up quite rapidly and also decrease rapidly when winds subside. The period and, therefore, length of wind waves is generally short relative to the period and length of waves propagated into the harbor (see Appendix A). The shorter period and length result in wind waves being characterized by choppy conditions. When wind waves are superimposed on deep water waves propagated into shallow water, the waves can become quite complex and confused. Under such conditions, when more than one source of waves is influencing a location, tending or joint operations can be hazardous even if the individual wave train heights are not significantly high. Vessels of various lengths may respond with different motions to the diverse wave lengths present. The information on wave periods, provided in the previous tables, should be considered when forecasts are made for joint operations of various length vessels.

3.7 Protective and Mitigating Measures

3.7.1 Moving to a New Anchorage

Moving from an outer anchorage into the Harbor will provide protection from southerly winds and waves. Protection from southerly winds and waves can also be gained by moving to the north side of Aiynia or Psittalia Islands, or north of any other island or peninsula. However, due caution must be used in selecting protection from southerly winds in light of the tendency for strong northerlies to follow southerlies when migratory cyclones move northeastward through the area. Protected anchorages can also be found in Elefsina Bay north of Salamis Island. Note that pilots are required when transiting Salamis Straits.

3.7.2 Scheduling

During periods of northerly flow afternoon winds along south-facing coasts, such as in the vicinity of Piraeus, are reduced by the sea breeze effects. During spring, summer and autumn seasons, under light-to-moderate northerly flow, a southerly sea breeze may be established. Due to this local countering of large scale by local scale winds during the warmest part of the day, the strongest northerly winds frequently occur before noon in the Piraeus area. Note that the sea breeze effect reinforces the northerly flow along north-facing coasts.

Nearshore and over land winds typically drop off after sunset due to the stabilizing influence of land areas on the atmospheric boundary layer. This effect is greatest when skies are clear and winds are from the north.

3.7.3 Fleet Landing Locations

The Fleet Landing for ships in Piraeus Harbor is located at the extreme southwestern corner of the Harbor (FICEURLANT, 1987). Ships anchored in the Falerou Bay area use the Fleet Landing at Flisous Marina which is located inside a breakwater extending northeastward into the southern part of Falirou Bay.

3.8 Local Indicators of Hazardous Weather Conditions

No local indicators were noted during the Port Visit of 1990. Reiter (1971) reported that increasing cloudiness over the Balkan Peninsula and Aegean Sea on the day preceding the establishment of an etesian wind period was a well-known fact by local fishermen. During the periods of May-June and September-October thunderstorms and lightning frequently occur on the day preceding the outbreak of the Etesian as well as on the first day of the Etesian. During July and August, when the most stable atmospheric conditions exist over the Mediterranean, scattered altocumulus are typically noted on the day preceding the onset of the Etesian.

3.9 Summary of Problems, Actions, and Indicators

Table 3-5 is intended to provide easy-to-use seasonal references for forecasters or ships using the Port of Piraeus. Table 2-1 (Section 2) summarizes Table 3-5 and is intended primarily for use by ship captains.

This page intentionally left blank

/

Table 3.5. POTENTIAL PROBLEM SITUATIONS AT

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAU
1. Anchorages Late Autumn, Winter and Spring - Migratory cyclones most intense in Winter - Sciroccos most intense in early Spring.	a. S'ly winds/waves - With migratory cyclones: Winds 28 to 40 kt (force 7-8), waves 15 to 20 ft (4 to 6 m), frontal clouds, precipitation and reduced visibility. May be followed by rapid shift to strong N'ly winds, squally unsettled weather and cold temperatures. Conditions generally limited to a day or two. With Sciroccos: Winds 22 to 33 kt (force 6-7), waves 5-7 ft (1-2 m), cloudy with widespread light rain, locally heavy in squalls. Conditions may last for several days.	a. The most hazardou passage of migratory of strong winds and anchor. Protected a of islands and in El for passage to Elefs When anchoring in ar southerly wind/waves sure should be consi rapid shift from str northerly winds.
Winter Conditions	b. NW-N'ly winds - Winds 34 to 47 kt (force 8-9). Freezing temperatures. Squally unsettled weather. Conditions may last for several days.	b. Strong off-shore weather. Changing c cause ships to swing atures (wind chill b weather gear and ope
Summer Conditions	c. N-NE'ly winds - Winds 34 to 40 kt (force 8) during most intense Etesian events. Conditions may last for several days and sometimes for weeks.	c. Northerly winds pr during strong Etesian southerly sea breeze afternoons. Vessel m operations may be aff

TIONS AT PORT OF PIRAEUS, GREECE -- ALL SEASONS

PRECAUTIONARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
: hazardous of conditions occur with migratory cyclones, combined effects :inds and high waves. Ships may drag :otected anchorages can be found north and in Elefsina Bay. Pilot required : to Elefsina Bay via Salamis Straits. ·ing in areas providing protection from :ind/waves, threat of northerly expo- l be considered due to tendency for : from strong southerly to stronger :inds.	a. Migratory cyclones approach from the western quadrant. Movement tends to be quite erratic. Approaching cyclones may stall over the Ionian Sea followed by development of a secondary cyclone and rapid movement northeastward through the local area. The synoptic scale pattern associated with winter cyclone development is generally well forecast by numerical guidance, however, early detection of secondary center development generally requires close scrutiny of satellite data and/or weather reports.
ff-shore winds with squally variable hanging conditions during squalls may to swing at anchor. Freezing temper- d chill below 0°F (-18°C)) make cold r and operations necessary.	b. Winter northerly winds result from high pressure over Europe and low pressure over the eastern Mediterranean. During winter the 500 mb circulations, starting two days before local onset of strong northerlies, typically has 500 mb ridge building into the north Atlantic and then moving eastward over western Europe with a large amplitude trough in advance of the ridge moving eastward across Europe. At the surface a migratory high moves east-southeastward from the United Kingdom to central Europe while surface cyclones are moving east-southeastward from the central to the eastern Mediterranean. A separate storm track exists across northern Europe. Numerical guidance should be quite reliable.
winds prevail throughout the day g Etesian events. Typical summer a breeze does not develop during Vessel maneuvering and alongside ay be affected.	c. During summer time strong Etesian events develop when the thermal trough that extends westward from Asia Minor along the southern coast of Turkey intensifies. Increasing cloudiness develops over the Balkan Peninsula area the day before onset of an Etesian. During July and August the cloudiness is in the form of altocumulus on the day before onset, during May-June and September-October periods scattered thunderstorm activity develops on the day before and first day of an Etesian. Etesian events most intense during July and August.

/

Table 3.5 (continu

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAUTIO
2. Small Boats, Outside harbor Late Autumn, Winter and Spring. - Migratory cyclones most intense in Winter - Sciroccos most intense in early Spring.	a. S'ly winds/waves - With migratory cyclones: Winds 28 to 40 kt (force 7-8), waves 15 to 20 ft (4 to 6 m), frontal clouds, precipitation and reduced visibility. May be followed by rapid shift to strong N'ly winds, squally unsettled weather and cold temperatures. Conditions generally limited to a day or two. With Sciroccos: Winds 22 to 33 kt (force 6-7), waves 5-7 ft (1-2 m), cloudy with widespread light rain, locally heavy in squalls. Conditions may last for several days. Persistent southerly flow may result in piling up of water in the Harbor with waves breaking over low docks used for Fleet Landing.	a. Small boat runs to/fr hazardous and likely cur age may swing with chang ing squalls. Swell and out of phase increasing and/or well deck operati Harbor and inside breakw vide protection from sou Ships in anchorages may north of various islands such moves are made, sma to follow or make runs t landings.
Winter Conditions	b. NW-N'ly winds - Winds 34 to 47 kt (force 8-9). Freezing temperatures. Squally unsettled weather. Conditions may last for several days.	b. Small boat operations curtailed. Rapid onset of results in variable wind particularly hazardous to temperatures, possible sn months.
Summer Conditions	c. N-NE'ly winds - Winds 34 to 40 kt (force 8) during most intense Etesian events. Conditions may last for several days and sometimes for weeks.	c. Small boat runs to/fro hazardous but not likely al winds from about 020° north and northeast of th hanced local winds over t sea breeze effects offset winds along south-facing tend to be lower during m than during morning and m cial for scheduling wind

3.5 (continued)

›RECAUTIONARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
runs to/from anchorages will be likely curtailed. Ships at anchor- with changing wind directions dur- Swell and local wind waves may be increasing hazards of alongside eck operations. Fleet landings in side breakwater of Falirou Bay pro- on from southerly winds and waves. orages may move to protected areas ous islands or to Elefsina Bay. If e made, small boats will not be able make runs to harbor or Falirous Bay	a. Migratory cyclones approach from the western quadrant. Movement tends to be quite erratic. Approaching cyclones may stall over the Ionian Sea followed by development of a secondary cyclone and rapid movement northeastward through the local area. The synoptic scale pattern associated with winter cyclone development is generally well forecast by numerical guidance, however, early detection of secondary center development generally requires close scrutiny of satellite data and/or weather reports.
operations outside harbor generally oid onset of strong coastal squalls riable wind and wave conditions hazardous to small craft. Freezing possible snow showers during winter	b. Winter northerly winds result from high pressure over Europe and low pressure over the eastern Mediterranean. During winter the 500 mb circulations starting two days before local onset of strong northerlies typically has 500 mb ridge building into the north Atlantic and then moving eastward over western Europe with a large amplitude trough in advance of the ridge moving eastward across Europe. At the surface a migratory high moves east-southeastward from the United Kingdom to central Europe while surface cyclones are moving east-southeastward from the central to the eastern Mediterranean. A separate storm track exists across northern Europe. Numerical guidance should be quite reliable.
runs to/from anchorages will be not likely to be canceled. Region- about 020° are funneled by terrain heast of the harbor, causing en- inds over the harbor. Afternoon ects offset northerly regional uth-facing coastlines, wind speeds er during mid to late afternoon rning and mid day. May be benefi- uling wind sensitive operations.	c. During summer time strong Etesian events develop when the thermal trough that extends westward from Asia Minor along the southern coast of Turkey intensifies. Increasing cloudiness develops over the Balkan Peninsula area the day before onset of an Etesian. During July and August the cloudiness is in the form of altocumulus on the day before onset, during May-June and September-October periods scattered thunderstorm activity develops on the day before and first day of an Etesian. Etesian events most intense during July and August.

1

Table 3.5 (continu

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAUTIOI
3. Arriving/Departing Late Autumn, Winter and Spring - Migratory cyclones most intense in Winter - Sciroccos most intense in early Spring.	a. S'ly winds/waves - With migratory cyclones: Winds 28 to 40 kt (force 7-8), waves 15 to 20 ft (4 to 6 m), frontal clouds, precipitation and reduced visibility. May be followed by rapid shift to strong N'ly winds, squally unsettled weather and cold temperatures. Conditions generally limited to a day or two. With Sciroccos: Winds 22 to 33 kt (force 6-7), waves 5-7 ft (1-2 m), cloudy with widespread light rain, locally heavy in squalls. Conditions may last for several days.	a. Following waves and wi maneuvering in approaches heavy cross traffic outsi Allow for shoreward drift Cross wind will be experi through harbor entrance.
Winter Conditions	b. NW-N'ly winds - Winds 34 to 47 kt (force 8-9). Freezing temperatures. Squally unsettled weather. Conditions may last for several days.	b. Prevailing head winds winds during passage thro Beware of tendency for ra speed and directions duri entry/departure until squ ed. Freezing temperature quire cold weather gear/o
Summer Conditions	c. N-NE'ly winds - Winds 34 to 40 kt (force 8) during most intense Etesian events. Conditions may last for several days and sometimes for weeks.	c. Funneling of winds ove area during strongest Ete handling problems at low h noon offset by southerly wind direction or at leas erly wind speeds. Wind s best scheduled for mid to

.5 (continued)

ECAUTIONARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
ves and winds may hamper low-speed approaches to Harbor. Expect ffic outside harbor entrance. ward drift at both anchorages. be experienced during passage entrance.	a. Migratory cyclones approach from the western quadrant. Movement tends to be quite erratic. Approaching cyclones may stall over the Ionian Sea followed by development of a secondary cyclone and rapid movement northeastward through the local area. The synoptic scale pattern associated with winter cyclone development is generally well forecast by numerical guidance, however, early detection of secondary center development generally requires close scrutiny of satellite data and/or weather reports.
ad winds in approach area, cross ssage through harbor entrance. ıcy for rapid fluctuations of wind ions during squalls. Delay of until squalls subside recommend- mperatures/low wind chills re- ıer gear/operations.	b. Winter northerly winds result from high pressure over Europe and low pressure over the eastern Mediterranean. During winter the 500 mb circulations starting two days before local onset of strong northerlies typically has 500 mb ridge building into the north Atlantic and then moving eastward over western Europe with a large amplitude trough in advance of the ridge moving eastward across Europe. At the surface a migratory high moves east-southeastward from the United Kingdom to central Europe while surface cyclones are moving east-southeastward from the central tc the eastern Mediterranean. A separate storm track exists across northern Europe. Numerical guidance should be quite reliable.
winds over Harbor and entrance ngest Etesian events will cause s at low headway speeds. After- outherly sea breeze may reverse r at least locally reduce north- . Wind sensitive events may be or mid to late afternoons.	c. During <u>summer time</u> strong Etesian events develop when the thermal trough that extends westward from Asia Minor along the southern coast of Turkey intensifies. Increasing cloudiness develops over the Balkan Peninsula area the day before onset of an Etesian. During July and August the cloudiness is in the form of altocumulus on the day before onset, during May-June and September-October periods scattered thunderstorm activity develops on the day before and first day of an Etesian. Etesian events most intense during July and August.

References

FICEURLANT, 1987: Port Directory for Piraeus, Greece. Fleet Intelligence Center Europe and Atlantic, Norfolk, VA.

Hydrographer of the Navy, 1970: Mediterranean Pilot. Volume III. Hydrographer of the Navy, London, England.

Shaver, D.W., Undated: Comments on Weather in the Mediterranean. Unpublished manuscript. Naval Oceanographic and Atmospheric Research Laboratory, Atmospheric Directorate, Monterey, CA 93943-5006*.

Reiter, E.R., 1971. Digest of Selected Weather Problems of the Mediterranean (NAVWEARSCHFAC T.P. 9-71). Naval Oceanographic and Atmospheric Research Laboratory, Atmospheric Directorate, Monterey, CA 93943-5006*.

Kotsch, W.J., 1983: Weather for the Mariner, Third Edition. Naval Institute Press, Annapolis, MD.

*Now Naval Research Laboratory, Monterey, CA 93943-5006.

Port Visit Information

May 1990: NOARL Meteorologists R. Fett and R. Miller met with the Senior Pilot, Mr. J. Roussos, to obtain much of the information included in this port evaluation.

APPENDIX A

General Purpose Oceanographic Information

This section provides general information on wave forecasting and wave climatology as used in this study. The forecasting material is not harbor specific. The material in paragraphs A.1 and A.2 was extracted from H.O. Pub. No. 603, Practical Methods for Observing and Forecasting Ocean Waves (Pierson, Neumann, and James, 1955). The information on fully arisen wave conditions (A.3) and wave conditions within the fetch region (A.4) is based on the JONSWAP model. This model was developed from measurements of wind wave growth over the North Sea in 1973. The JONSWAP model is considered more appropriate for an enclosed sea where residual wave activity is minimal and the onset and end of locally forced wind events occur rapidly (Thornton, 1986), and where waves are fetch limited and growing (Hasselmann, et al., 1976). Enclosed sea, rapid onset/subsiding local winds, and fetch limited waves are more representative of the Mediterranean waves and winds than the conditions of the North Atlantic from which data was used for the Pierson and Moskowitz (P-M) Spectra (Neumann and Pierson 1966). The P-M model refined the original spectra of H.O. 603, which over developed wave heights.

The primary difference in the results of the JONSWAP and P-M models is that it takes the JONSWAP model longer to reach a given height or fully developed seas. In part this reflects the different starting wave conditions. Because the propagation of waves from surrounding areas into semi-enclosed seas, bays, harbors, etc. is limited, there is little residual wave action following periods of locally light/calm winds and the sea surface is nearly flat. A local wind developed wave growth is therefore slower than wave growth in the open ocean where some residual wave action is generally always present. This slower wave development is a built in bias in the formulation of the JONSWAP model which is based on data collected in an enclosed sea.

A.1 Definitions

Waves that are being generated by local winds are called "SEA". Waves that have traveled out of the generating area are known as "SWELL". Seas are chaotic in period, height and direction while swell approaches a simple sine wave pattern as its distance from the generating area increases. An in-between state exists for a few hundred miles outside the generating area and is a condition that reflects parts of both of the above definitions. In the Mediterranean area, because its fetches and open sea expanses are limited, SEA or IN-BETWEEN conditions will prevail. The "SIGNIFICANT WAVE HEIGHT" is defined as the average value of the heights of the one-third highest waves. PERIOD and WAVE LENGTH refer to the time between passage of, and distances between, two successive crests on the sea surface. The FREQUENCY is the reciprocal of the period ($f = 1/T$) therefore as the period increases the frequency decreases. Waves result from the transfer of energy from the wind to the sea surface. The area over which the wind blows is known as the FETCH, and the length of time that the wind has blown is the DURATION. The characteristics of waves (height, length, and period) depend on the duration, fetch, and velocity of the wind. There is a continuous generation of small short waves from the time the wind starts until it stops. With continual transfer of energy from the wind to the sea surface the waves grow with the older waves leading the growth and spreading the energy over a greater range of frequencies. Throughout the growth cycle a SPECTRUM of ocean waves is being developed.

A.2 Wave Spectrum

Wave characteristics are best described by means of their range of frequencies and directions or their spectrum and the shape of the spectrum. If the spectrum of the waves covers a wide range of frequencies and directions (known as short-crested conditions), SEA conditions prevail. If the spectrum covers a narrow range of frequencies and directions (long crested conditions), SWELL conditions prevail. The wave spectrum depends on the duration of the wind, length of the fetch, and on the wind velocity. At a given wind speed and given state of wave development, each spectrum has a band of frequencies where most of the total energy is concentrated. As the wind speed increases the range of significant frequencies extends more and more toward lower frequencies (longer periods). The frequency of maximum energy is given in equation 1.1 where v is the wind speed in knots.

$$f_{max} = \frac{2.476}{v} \qquad (1.1)$$

The wave energy, being a function of height squared, increases rapidly as the wind speed increases and the maximum energy band shifts to lower frequencies. This results in the new developing smaller waves (higher frequencies) becoming less significant in the energy spectrum as well as to the observer. As larger waves develop an observer will pay less and less attention to the small waves. At the low frequency (high period) end the energy drops off rapidly, the longest waves are relatively low and extremely flat, and therefore also masked by the high energy frequencies. The result is that 5% of the upper frequencies and 3% of the lower frequencies can be cut-off and only the remaining frequencies are considered as the "significant part of the wave spectrum". The resulting range of significant frequencies or periods are used in defining a fully arisen sea. For a fully arisen sea the approximate average period for a given wind speed can be determined from equation (1.2).

$$\bar{T} = 0.285v \qquad (1.2)$$

Where v is wind speed in knots and $\bar{T}$ is period in seconds. The approximate average wave length in a fully arisen sea is given by equation (1.3).

$$\bar{L} = 3.41\ \bar{T}^2 \qquad (1.3)$$

Where $\bar{L}$ is average wave length in feet and $\bar{T}$ is average period in seconds.

The approximate average wave length of a fully arisen sea can also be expressed as:

$$\bar{L} = .67\text{"L"} \qquad (1.4)$$

where "L" = $5.12T^2$, the wave length for the classic sine wave.

A.3 Fully Arisen Sea Conditions

For each wind speed there are minimum fetch (n mi) and duration (hr) values required for a fully arisen sea to exist. Table A-1 lists minimum fetc and duration values for selected wind speeds, values of significant wave (average of the highest 1/3 waves) period and height, and wave length of the average wave during developing and fully arisen seas. The minimum duration time assumes a start from a flat sea. When pre-existing lower waves exist the time to fetch limited height will be shorter. Therefore the table duration time represents the maximum duration required.

Table A-1. Fully Arisen Deep Water Sea Conditions Based on the JONSWAP Model.

Wind Speed (kt)	Minimum Fetch/Duration (n mi) (hrs)	Sig Wave (H1/3 Period/Height (sec) (ft)	Wave Length (ft)[1,2] Developing/Fully /Arisen L X (.5) /L X (.67)
10	28 / 4	4 / 2	41 / 55
15	55 / 6	6 / 4	92 / 123
20	110 / 8	8 / 8	164 / 220
25	160 / 11	9 / 12	208 / 278
30	210 / 13	11 / 16	310 / 415
35	310 / 15	13 / 22	433 / 580
40	410 / 17	15 / 30	576 / 772

NOTES:

[1] Depth throughout fetch and travel zone must be greater than 1/2 the wave length, otherwise shoaling and refraction take place and the deep water characteristics of waves are modified.

[2] For the classic sine wave the wave length (L) equals 5.12 times the period (T) squared ($L = 5.12T^2$). As waves develop and mature to fully developed waves and then propagate out of the fetch area as swell there wave lengths approach the classic sine wave length. Therefore the wave lengths of developing waves are less than those of fully developed waves which in turn are less than the length of the resulting swell. The factor of .5 (developing) and .67 (fully developed) reflect this relationship.

A.4 Wave Conditions Within The Fetch Region

Waves produced by local winds are referred to as SEA. In harbors the local sea or wind waves may create hazardous conditions for certain operations. Generally within harbors the fetch lengths will be short and therefore the growth of local wind waves will be fetch limited. This implies that there are locally determined upper limits of wave height and period for each wind velocity. Significant changes in speed or direction will result in generation of a new wave group with a new set of height and period limits. Once a fetch limited sea reaches its upper limits no further growth will occur unless the wind speed increases.

Table A-2 provides upper limits of period and height for given wind speeds over some selected fetch lengths. The duration in hours required to reach these upper limits (assuming a start from calm and flat sea conditions) is also provided for each combination of fetch length and wind speed. Some possible uses of Table A-2 information are:

1) If the only waves in the area are locally generated wind waves, the Table can be used to forecast the upper limit of sea conditions for combinations of given wind speeds and fetch length.

2) If deep water swell is influencing the local area in addition to locally generated wind waves, then the Table can be used to determine the wind waves that will combine with the swell. Shallow water swell conditions are influenced by local bathymetry (refraction and shoaling) and will be addressed in each specific harbor study.

3) Given a wind speed over a known fetch length the maximum significant wave conditions and time needed to reach this condition can be determined.

Table A-2. Fetch Limited Wind Wave Conditions and Time Required to Reach These Limits (Based on JONSWAP Model). Enter the table with wind speed and fetch length to determine the significant wave height and period, and time duration needed for wind waves to reach these limiting factors. All of the fetch/speed combinations are fetch limited except the 100 n mi fetch and 18 kt speed.

Format: height (feet)/period (seconds)
duration required (hours)

Fetch Length (n mi) \ Wind Speed (kt)	18	24	30	36	42
10	2/3-4 1-2	3/3-4 2	3-4/4 2	4/4-5 1-2	5/5 1-2
20	3/4-5 2-3	4/4-5 3	5/5 3	6/5-6 3-4	7/5-6 3
30	3-4/5 3	5/5-6 4	6/6 3-4	7/6 3-4	8/6-7 3
40	4-5/5-6 4-5	5/6 4	6-7/6-7 4	8/7 4	9-10/7-8 3-4
100	5/6-7[1] 5-6	9/8 8	11/9 7	13/9 7	15-16/9-10 7

[1] 18 kt winds are not fetch limited over a 100 n mi fetch.

An example of expected wave conditions based on Table A-2 follows:

WIND FORECAST OR CONDITION

An offshore wind of about 24 kt with a fetch limit of 20 n mi (ship is 20 n mi from the coast) is forecast or has been occurring.

SEA FORECAST OR CONDITION

From Table A-2: If the wind condition is forecast to last, or has been occurring, for at least 3 hours: Expect sea conditions of 4 feet at 4-5 second period to develop or exist. If the condition lasts less than 3 hours the seas will be lower. If the condition lasts beyond 3 hours the sea will not grow beyond that developed at the end of about 3 hours unless there is an increase in wind speed or a change in the direction that results in a longer fetch.

A.5 Wave Climatology

The wave climatology used in these harbor studies is based on 11 years of Mediterranean SOWM output. The MED-SOWM is discussed in Volume II of the U.S. Naval Oceanography Command Numerical Environmental Products Manual (1986). A deep water MED-SOWM grid point was selected as representative of the deep water wave conditions outside each harbor. The deep water waves were then propagated into the shallow water areas. Using linear wave theory and wave refraction computations the shallow water climatology was derived from the modified deep water wave conditions. This climatology does not include the local wind generated seas. This omission, by design, is accounted for by removing all wave data for periods less than 6 seconds in the climatology. These shorter period waves are typically dominated by locally generated wind waves.

A.6 Propagation of Deep Water Swell Into Shallow Water Areas

When deep water swell moves into shallow water the wave patterns are modified, i.e., the wave heights and directions typically change, but the wave period remains constant. Several changes may take place including shoaling as the wave feels the ocean bottom, refraction as the wave crest adjusts to the bathymetry pattern, changing so that the crest becomes more parallel to the bathymetry contours, friction with the bottom sediments, interaction with currents, and adjustments caused by water temperature gradients. In this work, only shoaling and refraction effects are considered. Consideration of the other factors are beyond the resources available for this study and, furthermore, they are considered less significant in the harbors of this study than the refraction and shoaling factors.

To determine the conditions of the deep water waves in the shallow water areas the deep water conditions were first obtained from the Navy's operational MED-SOWM wave model. The bathymetry for the harbor/area of interest was extracted from available charts and digitized for computer use. Figure A-1 is a sample plot of bathymetry as used in this project. A ray path refraction/shoaling program was run for selected combinations of deep water wave direction and period. The selection was based on the near deep water wave climatology and harbor exposure. Each study area requires a number of ray path computations. Typically there are 3 or 4 directions (at 30° increments) and 5 or 6 periods (at 2 second intervals) of concern for each area of study. This results in 15 to 24 plots per area/harbor. To reduce this to a manageable format for quick reference, specific locations within each study area were selected and the information was summarized and is presented in the specific harbor studies in tabular form.

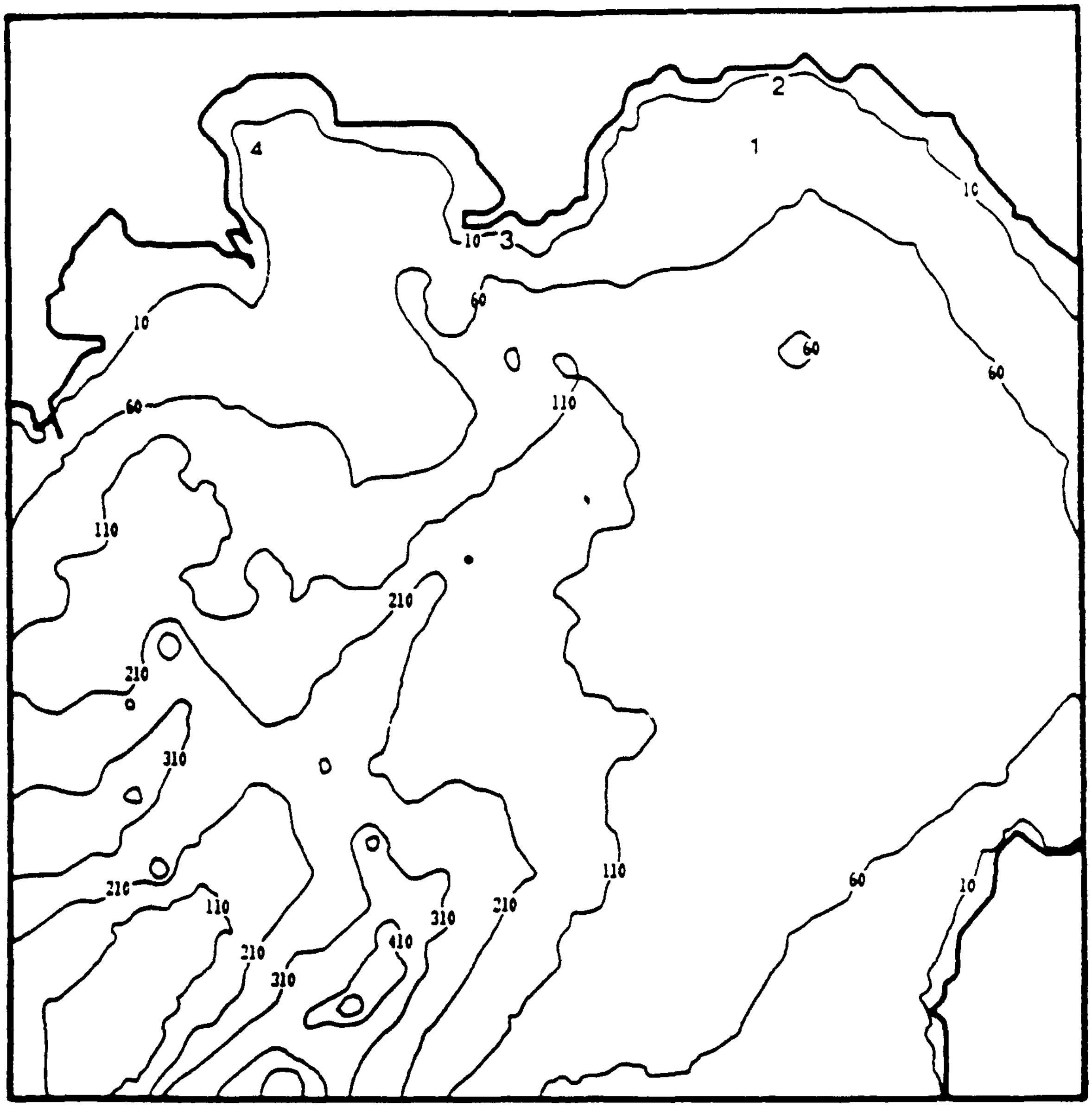


Figure A-1. Example plot of bathymetry (Naples harbor) as used in this project. For plotting purposes only, contours are at 50 fathom intervals from an initial 10 fathom contour. The larger size numbers identify specific anchorage areas addressed in the harbor study.

REFERENCES

Hasselmann, K. D., D. B. Ross, P. Muller, and W. Sell, 1976: A parametric wave prediction model. J. Physical Oceanography, Vol. 6, pp. 208-228.

Neumann, G., and W. J. Pierson Jr., 1966: Principles of Physical Oceanography. Prentice-Hall, Englewood Cliffs.

Pierson, W.J. Jr., G. Neumann, and R. W. James, 1955: Practical Methods for Observing and Forecasting Ocean Waves, H.O. Pub. No. 603.

Thornton, E. B., 1986: Unpublished lecture notes for OC 3610, Waves and Surf Forecasting. Naval Postgraduate School, Monterey CA.

U. S. Naval Oceanography Command, 1986: Vol. II of the U.S. Naval Oceanography Command Numerical Environmental Products Manual.

DISTRIBUTION

SNDL

21A1	CINCLANTFLT
21A3	CINCUSNAVEUR
22A1	COMSECONDFLT
22A3	COMSIXTHFLT
23B3	Special Force Commander EUR
24A1	Naval Air Force Commander LANT
24D1	Surface Force Commander LANT
24E	Mine Warfare Command
24G1	Submarine Force Commander LANT
26QQ1	Special Warfare Group LANT
28A1	Carrier Group LANT (2)
28B1	Cruiser-Destroyer Group LANT (2)
28D1	Destroyer Squadron LANT (2)
28J1	Service Group and Squadron LANT (2)
28K1	Submarine Group and Squadron LANT
28L1	Amphibious Squadron LANT (2)
29A1	Guided Missile Cruiser LANT
29B1	Aircraft Carrier LANT
29D1	Destroyer LANT (DO 931/945 Class)
29E1	Destroyer LANT (DO 963 Class)
29F1	Guided Missile Destroyer LANT
29G1	Guided Missile Frigate (LANT)
29I1	Frigate LANT (FF 1098)
29J1	Frigate LANT (FF 1040/1051 Class)
29K1	Frigate LANT (FF 1052/1077 Class)
29L1	Frigate LANT (FF 1078/1097 Class)
29N1	Submarine LANT #SSN)
29Q	Submarine LANT SSBN
29R1	Battleship Lant (2)
29AA1	Guided Missile Frigate LANT (FFG 7)
29BB1	Guided Missile Destroyer (DDG 993)
31A1	Amphibious Command Ship LANT (2)
31B1	Amphibious Cargo Ship LANT
31G1	Amphibious Transport Ship LANT
31H1	Amphibious Assault Ship LANT (2)
31I1	Dock Landing Ship LANT
31J1	Dock Landing Ship LANT
31M1	Tank Landing Ship LANT
32A1	Destroyer Tender LANT
32C1	Ammunition Ship LANT
32G1	Combat Store Ship LANT
32H1	Fast Combat Support Ship LANT
32N1	Oiler LANT
32Q1	Replenishment Oiler LANT
32S1	Repair Ship LANT
32X1	Salvage Ship LANT

32DD1	Submarine Tender LANT
32EE1	Submarine Rescue Ship LANT
32KK	Miscellaneous Command Ship
32QQ1	Salvage and Rescue Ship LANT
32TT	Auxiliary Aircraft Landing Training Ship
42N1	Air Anti-Submarine Squadron VS LANT
42P1	Patrol Wing and Squadron LANT
42BB1	Helicopter Anti-Submarine Squadron HS LANT
42CC1	Helicopter Anti-Submarine Squadron Light HSL LANT
C40	Monterey, Naples, Sigonella and Souda Bay only
FD2	Oceanographic Office - NAVOCEANO
FD3	Fleet Numerical Oceanography Center - FLENUMOCEANCEN
FD4	Oceanography Center - NAVEASTOCEANCEN
FD5	Oceanography Command Center - COMNAVOCEANCOM (Rota)

copy to:

21A2	CINCPACFLT
22A2	Fleet Commander PAC
24F	Logistics Command
24H1	Fleet Training Command LANT
28A2	Carrier Group PAC (2)
29B2	Aircraft Carrier PAC (2)
29R2	Battleships PAC (2)
31A2	Amphibious Command Ship PAC (2)
31H2	Amphibious Assault Ship PAC (2)
FA2	Fleet Intelligence Center
FC14	Air Station NAVEUR
FD1	Oceanography Command
USDAO	France, Israel, Italy and Spain

USCINCENT
Attn: Weather Div. (CCJ3-W)
MacDill AFB, FL 33608-7001

Chief of Naval Research
Library, Code 01232L
Ballston Tower #1
800 Quincy St.
Arlington, VA 22217-5000

Office of Naval Research
Code 1122 MM, Marine Meteo.
Arlington, VA 22217-5000

Commandant
Hdq. U.S. Marine Corps
Washington, DC 20380

Officer in Charge
NAVOCEANCOMDET
Naval Educ. & Trng. Center
Newport, RI 02841-5000

Commanding Officer
Naval Research Lab
Attn: Library, Code 2620
Washington, DC 20390

Chairman
Oceanography Dept.
U.S. Naval Academy
Annapolis, MD 21402

NAVPGSCOL
Meteorology Dept. Code 63
Monterey, CA 93943-5000

Naval War College
Attn: Geophys. Officer
NAVOPS Dept.
Newport, RI 02841

COMSPAWARSYSCOM
Code 3213, Navy Dept.
Washington, DC 20363-5100

USAFETAC/TS
Scott AFB, IL 62225

Commanding Officer
USCG Rsch. & Dev. Center
Groton, CT 06340

NOARL
Attn: Code 125P
SSC, MS 39529-5004

NOARL
Attn: Code 125L (10)
SSC, MS 39529-5004

Commander
Coastal Eng. Rsch. Cen
Kingman Bldg.
Ft. Belvoir, VA 22060

Central Intelligence Agency
Attn: OCR Standard Dist.
Washington, DC 20505

Defense Logistics Studies
Information Exchange
Army Logistics Manage. Cen.
Ft. Lee, VA 23801

Commanding Officer
USCG RESTRACEN
Yorktown, VA 23690

NOAA
Oceanographic Servs. Div.
6010 Executive Blvd.
Rockville, MD 20852

National Climatic Center
Attn: L. Preston D542X2
Federal Bldg. - Library
Asheville, NC 28801

NOAA Rsch. Facilities Center
P.O. Box 520197
Miami, FL 33152

Chief, International Affairs
National Weather Service
8060 13th Street
Silver Spring, MD 20910

Scripps Institution of
Oceanography Library
Documents/Reports Section
La Jolla, CA 92037

Oceanroutes, Inc.
680 W. Maude Ave.
Sunnyvale, CA 94086-3518

Istituto Universitario Navale
Facilta Di Scienze Nautiche
Istituto Di Meteorolgia E
Oceanografia, 80133 Napoli
Via Amm, Acton, 38 Italy

NOARL-W
Attn: D. Perryman
Monterey, CA 93943-5006

Director, Institute of
Physical Oceanography
Haraldsgade 6
2200 Copenhagen N.
Denmark

The British Library
Science Reference Library (A)
25 Southampton Bldgs.
Chancery Lane
London WC2A 1AW

Commander in Chief
Attn: Staff Meteorologist &
Oceanography Officer
Northwood, Middlesex HA6 3HP
England

Meteorologie Nationale
SMM/Documentation
2, Avenue Rapp
75340 Paris Cedex 07
France

Meteorologie Nationale
1 Quai Branly
75, Paris (7)
France

Ozeanographische
Forschungsantalt Bundeswehr
Lornsenstrasse 7, Kiel
Federal Republic of Germany

Institut fur Meereskunde Der
Universitat Hamburg
Heimhuderstrasse 71
2000 Hamburg 13
Federal Republic of Germany

Consiglio Nazionale Delle
Ricerche
Istituto Talassografico Di
Trieste, Viale R. Gessi 2
34123 Trieste, Italy

Centro Nazionale Di Meteorolo.
E Climatologia Aeronautica
Piazzale Degli Archivi 34
00144 Roma, Italy

Director, SACLANT ASW
Research Centre
Viale San Bartolomeo, 400
I-19026 La Spezia, Italy

Mr. Dick Gilmore
2145 N. Fairway Ct.
Oak Harbor, WA 98277

Director of Naval Oceano.
& Meteorology
Ministry of Defence
Old War Office Bldg.
London, S.W.1. England

Belgian Air Staff
VS3/CTL-MET
Everestraat 1
1140 Brussels
Belgium

Library, Institute of
Oceanographic Sciences
Attn: Director
Wormley, Godalming
Surry GU8 5UB, England

Service Hydrographique EtT
Oceanographique De La Marine
Establissement Principal
Rue Du Chatellier, B.P. 426
29275 - Brest Cedex, France

Direction De La Meteorologie
Attn: J. Dettwiller, MN/RE
77 Rue De Sevres
92106 Boulogne-Billancourt
Cedex, France

Institut fur Meereskunde
An Der Universitat Kiel
Dusternbrooker Weg 20
23 Kiel
Federal Republic of Germany

Director, Deutsches
Hydrographisches Institut
Tauschstelle, Postfach 220
02000 Hamburg 4
Federal Republic of Germany

Commander, D.W. Taylor
Naval Ship Center
Surface Ship Dynamics Br.
Attn: S. Bales
Bethesda, MD 20084-5000

Commanding Officer
Naval Unit
LNW/STOP 62
Chanute AFB, IL 61868-5000

Director
NAVSURFWEACEN, White Oaks
Navy Science Asst. Program
Silver Spring, MD 20903-5000

3350TH Tech. Trng Group
TTGU/2/STOP 623
Chanute AFB, IL 61868

U.S. Army Research Office
Attn: Geophysics Div.
P.O. Box 12211
Research Triangle Park, NC

Director
Library, Tech. Info. Cen.
Army Eng. Waterways Station
Vicksburg, MS 39180

Director, Env. & Life Sci.
Office of Undersec of Defense
for Rsch. & Env. E&LS
Rm. 3D129, The Pentagon
Washington, DC 20301

Director, Tech. Information
Defense Adv. Rsch. Projects
1400 Wilson Blvd.
Arlington, VA 22209

Chief, Marine Sci. Section
U.S. Coast Guard Academy
New London, CT 06320

Commander
NAVSURFWEACEN, Code R42
Dr. Katz, White Oaks Lab
Silver Spring, MD 20903-5000

Drector, Atlantic Marine
Center, NOAA
Coast & Geodetic Survey,
9 W. York St.
Norfolk, VA 23510

Asst. for Env. Sciences
Asst. SECNAV (R&D)
Room 5E731, The Pentagon
Washington, DC 20350

Head, Office of Oceano.
& Limnology
Smithsonian Institution
Washington, DC 20560

Office of Naval Research
Code 1122AT, Atmos. Sciences
Arlington, VA 22217-5000

Jefe del, Servicio de Aplica.
Aeronauticas y Maritimas
Instituto Nacional de Meteoro
Calle Universitaria
Apartado 285, 28071 Madrid
Espana SPAIN

The Joint Staff (J-3/ESD)
Environmental Services Div.
Operations Directorate
Washington, DC 20318-3000

Danish Defence Weather Serv.
Chief of Defence
P.O. Box 202
DK-2950 vedbaek DENMARK

Superintendent
Library Reports
U.S. Naval Academy
Annapolis, MD 21402

Director of Research
U.S. Naval Academy
Annapolis, MD 21402

NAVPGSCOL
Attn: Library
Monterey, CA 93943-5002

Commander
Naval Safety Center
Naval Air Station
Norfolk, VA 23511

Federal Coord. for Meteoro.
Servs. & Sup. Rsch. (OFCM)
11426 Rockville Pike, Rm 300
Rockville, MD 20852

Director
National Oceano. Data Center
E/OC23, NOAA
Washington, DC 20235

Science Applications
Intl. Corp. (SAIC)
205 Montecito Ave.
Monterey, CA 93940

REPORT DOCUMENTATION PAGE

Form Approved
OBM No. 0704-0188

1. Agency Use Only *(Leave blank).*

2. Report Date. September 1992

3. Report Type and Dates Covered. Final

4. Title and Subtitle.
Severe Weather Guide - Mediterranean Ports - 45. Piraeus

5. Funding Numbers.
Program Element No. O&M,N
Project No. --
Task No. --
Accession No. DN656794
Work Unit No. O&M,N-1

6. Author(s).
R.E. Englebretson & R.D. Gilmore (SAIC)
D.C. Perryman (NOARL)

7. Performing Organization Name(s) and Address(es).
Science Applications International Corporation (SAIC)
205 Montecito Avenue, Monterey, CA 93940
Naval Oceanographic and Atmospheric Research Laboratory
(NOARL), Atmospheric Directorate, Monterey, CA 93943-5006

8. Performing Organization Report Number.
NOARL Technical Note 237

9. Sponsoring/Monitoring Agency Name(s) and Address(es).
Naval Oceanography Command
Stennis Space Center, MS 39529-5000

10. Sponsoring/Monitoring Agency Report Number.
NOARL Technical Note 237

11. Supplementary Notes.

12a. Distribution/Availability Statement.
Approved for public release; distribution is unlimited.

12b. Distribution Code.

13. Abstract *(Maximum 200 words).*

This handbook for the port of Piraeus, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

14. Subject Terms.
Storm haven — Mediterranean meteorology
Piraeus port — Mediterranean oceanography

15. Number of Pages. 65

16. Price Code.

17. Security Classification of Report.	18. Security Classification of This Page.	19. Security Classification of Abstract.	20. Limitation of Abstract.
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	Same as report